KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: DECEMBER 1, 1891.

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BRITISH MOSSES.*

By the Rt. Hon. LORD JUSTICE FRY, F.R.S., F.S.A., F.L.S.

LORD BACON thought that a Moss was "but a rudiment between putrefaction and a herb." Mr. Ruskin thought, and perhaps thinks (he is at war, he tells us, with the botanists), "that the pineapple is really a Moss." People popularly talk of Club-Mosses and Stag-Mosses. Now all these usages of the word may be useful to us when we begin to think about Mosses, if we will make the right use of them, *i.e.*, if we will absolutely reverse them. A Moss is not a rudiment between a putrefaction and a herb, but a delicately, exquisitely organized plant. No possible stretch of the conception of a Moss can make it include a pineapple any more than an elephant; and the stag and club-Mosses of popular speech belong to a group of plants quite different from the Mosses, and of a far higher organization.

What then is a Moss? This is a question not to be hastily answered, and will I think be best answered at the end and not at the beginning of this paper. If you are working deductively, your definitions may come at the beginning; but if by patient investigation into natural facts, beware of starting with definitions—they ought to be the ripest fruit of your longest labour.

Vegetable productions are commonly divided into two great groups: those which possess obvious blossoms, or Phanerogams, and those which possess no obvious blossoms, or Cryptogams. The Cryptogams are again divided into two great groups—those whose structure is built up of cells without regularly formed vessels, such as sea weeds, fungi and lichens, the cellular Cryptogams; and those which, like the ferns and the club-Mosses, possess, in addition to cells, regularly formed vessels; these are known as Vascular Cryptogams.

This brief explanation will be enough to enable the reader to learn from the following table, which is arranged in an ascending rank, something as to the position of the Mosses in the vegetable kingdom, and the principal groups into which they may be divided:—

TABLE A.

		Series.	Orders.	Examples.
Vascular Cryptogams				
Muscineæ	i. Musci.	Pleurocarpæ		Hypnum
		Acrocarpæ	Stegocarpæ	Polytrichum
			Cleistocarpæ	Phascum
		Anomaleæ	Schizocarpæ	Andræa
			Holocarpæ	Archidium
	ii. Sphagnaceæ			
	iii. Hepaticeæ.	Jungermanniaceæ		
		Marchantiaceæ		
Algæ, &c.				

From this table it will be gathered that the Mosses, using that word in its wide signification, stand at the head of the cellular cryptogams, and that above them are the vascular cryptogams, of which, as I have already said, the ferns are one of the best-known groups. From these vascular cryptogams the Mosses are, however, separated by a distance which Goebel has described as a chasm "the widest with which we are acquainted in the whole vegetable kingdom." Perhaps, however, at some future time it may be found that even over this gulf Nature has thrown some slender bridge.

From the table it will be further seen that the larger group of the Muscineæ divides itself into three principal smaller groups: the Hepaticeæ or liverworts, the Sphagnaceæ or turf Mosses, and the Musci or true Mosses—Urn-Mosses, as they have been called, from the form of their capsule. These three divisions the Germans conveniently name as Leber-Moose, Torf-Moose, and Laub-Moose.

Now I will ask the reader to look at the column under the word "Series." The Pleurocarpæ or Pleurocarpous Mosses are those which carry their capsules on stalks proceeding from the sides of the axis of growth; the Acrocarpæ or Acrocarpous Mosses are those which bear these capsules on the top of their axis of growth. This

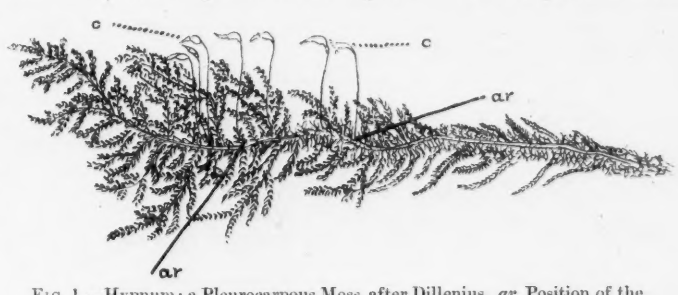


FIG. 1.—Hypnum: a Pleurocarpous Moss, after Dillenius. *ar.* Position of the Archegones. *c c.* Capsules.

* This paper has grown out of a discourse at the Royal Institution, given by the author in January, 1891.

distinction will be readily understood by comparing Fig. 1, which is a Pleurocarpous Moss, with Figs. 2 and 3, which represent an Acrocarpous Moss; in the former it will be seen that the axis, or line of growth, is horizontal, that the plant, in short, grows along the ground, whilst in the latter the direction of growth is vertical.

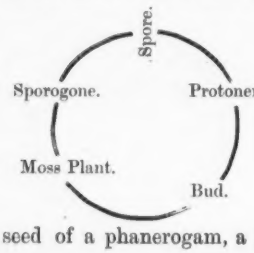
Fig. 3.—Polytrichum: Male Plant. After Dillenius. *a*. Male Blossom.

Again, in the former the capsules *c c* are seen carried on stalks originating from the principal stem, whilst in Fig. 2 the capsule *a* crowns the line of growth.

This distinction in the mode of carrying the capsule is one of great importance in the classification of Mosses, and the student who desires to begin to learn them should pay early attention to it. Often it is perfectly easy of application, but intermediate forms occur which are puzzles, and go to show that the chasm between the two forms is bridged over in Nature.

Fig. 2.—Polytrichum: an Acrocarpous Moss Female Plant, after Dillenius. *ar*. Position of archegone. *s*. Seta. *a*. Capsule and appendages. *c* and c^1. Capsule. *o*. Operculum. *cal*. Calyptra.

Life-History.—I propose now to trace the life-history of a Moss in its most complete course of life, and I shall then show how, in many cases, this course is abbreviated. It will be found that the full cycle of life may be indicated in the following circular form:—



so that, starting with a spore of one generation, and travelling to our right hand, we return to another spore which will give rise to a new circle of life.

(1) The spore is a simple cell; how produced we shall hereafter see. It is, I say, a simple cell, and not like the seed of a phanerogam, a highly complex organism. The spores are often seen to be emitted in vast numbers from the cases in which they are produced, and sometimes are brightly coloured—red, green, or yellow. Fig. 4 represents (highly magnified) the spore of a common Moss, the Funaria hygrometrica.

Fig. 4.—Spore of Funaria hygrometrica. After Schimper.

(2) From the spore proceeds the protonema, a line of cells, extending by transverse divisions, so that it comes to consist of single cells joined end to end to one another—an organism indistinguishable from the hypha of an Alga. At points this hypha throws off lateral branches, which are always of less diameter than the principal ones. There is thus produced a tangled mat of fibres, running on or near the surface of the ground, and often coloured by chlorophyll. This is the green stuff so often seen in flower-pots which have been allowed to get too damp. At points in the primary hypha cells begin to divide in a new fashion—not by transverse septa as before, but by septa differently inclined, so as to produce the rudiments of leaves; and the direction of growth changes from horizontal to vertical. Thus is formed (3) the bud, which by growth gives rise to (4) the Moss plant.

Fig. 5.—Spore with young Protonema. After Schimper.

This course of development is illustrated by Figs. 5 and 6. Fig. 5 shows at *a* the remains of the cell which has burst in emitting the hypha, or cellular projection to the right. Fig. 6 shows the same plant further advanced in

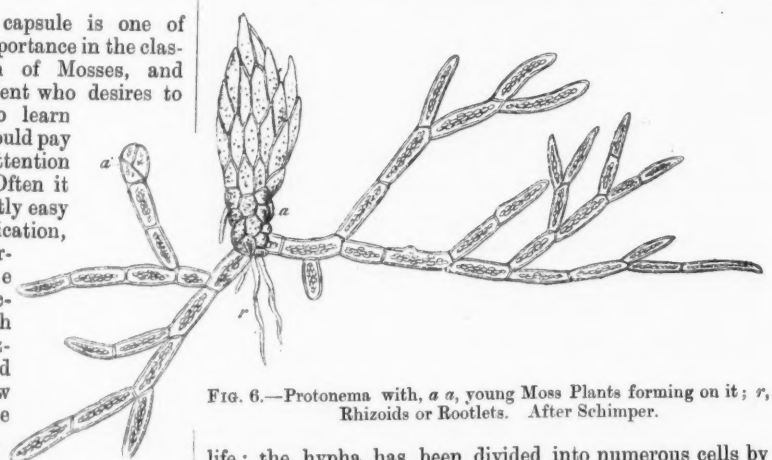


Fig. 6.—Protonema with, *a a*, young Moss Plants forming on it; *r*, Rhizoids or Rootlets. After Schimper.

life; the hypha has been divided into numerous cells by the transverse septa or walls; lateral branches have grown. Two letters *a* will be observed on the diagram. At the left hand *a* the divisions of the cells have assumed a new inclination so as to cut the cells into rudimentary leaves, and we have the first promise of the Moss plant. At the right hand *a* we have another Moss plant in a far more advanced stage, showing distinct traces of leaves, and having thrown out rootlets (*r*) downwards. The Moss plant when mature assumes generally, but not universally, a form referable to one or other of the two types already described, either the pleurocarpous form shown by Fig. 1 or the acrocarpous form shown in Fig. 2. This Moss plant is a structure of very considerable complexity, and often of great beauty of form. Sometimes it assumes the likeness of some of the smaller and more delicate ferns; but very rarely would it be taken for a flowering plant, even by a casual observer.

The Moss plant produces organs with two distinct functions, comparable the one to the pistil and ovary,

and the other to the stamens including the anthers of a flowering plant. The organ corresponding with the pistil is called the archegonium or archegone; the organs corresponding with the stamens the antheridia or antherids. The archegone is a flask-shaped organ, which ultimately produces a specialized cell, known as the oosphere, at the bottom of the flask, the neck of which is perforated by a canal. This organ is usually surrounded by circles of leaves, often larger and almost always different in form from the ordinary leaves of the Moss. The ordered arrangement of these leaves produces something like a flower, and is known as the perichætium, *i.e.*, the surroundings of the couch. If the reader will turn to Figs. 1 and 2, and note the letters *a r*, they will indicate the situation of the archegone before it gave rise to the capsule.

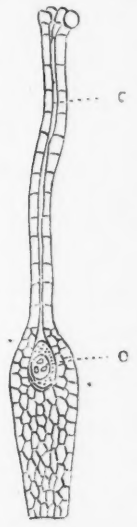


FIG. 7.—Archegone greatly magnified. *c*. Canal. *o*. Oosphere. After Berkeley.

Fig. 7 will show an archegone, with the canal, *c*, and the oosphere, *o*.

The male organs are known as antherids. Fig. 8 shows an antherid, a long bag-like cell, surrounded by filaments, sometimes club-shaped, called paraphyses. These are usually associated in groups, and surrounded by specialized leaves, often in the shape of a rosette, and when (as sometimes) they are highly coloured they present the aspect of small but beautiful flowers. Fig. 3 exhibits a male plant of one of our common Mosses, the Polytrichum, terminating in the rosette-shaped flower of a scarlet colour, composed of the antherids, the paraphyses, and the specialized leaves. The large beds of these short stiff male plants of Polytrichum, which may often be seen in the spring of the year, are objects of great, but, I fear, often neglected, beauty.

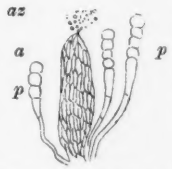


FIG. 8.—Antherid, *a*, with Paraphyses, *p*. *az*, Escaping Antherizoids. After Berkeley.

The antherids burst and give out swarms of small bodies, known as antherizoids, consisting of roundish cells containing in the interior a spiral thread, which produces a rotatory movement in the containing cell. Fig. 9 represents such antherizoids. These little bodies find their way to the canals of the archegone, pass down it, and enter the oosphere, and so effect that union of two independent cells which produces fertilization.

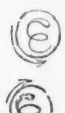


FIG. 9. Antherizoids, showing spiral threads. After Schimper.

(To be continued.)

A GOSSIP ON GHOST-NAMES.

By CANON ISAAC TAYLOR, M.A., LL.D., LITT.D.,
Author of "Words and Places," &c.

A GOOD many words have crept into our dictionaries which are not words at all, having arisen from uncorrected misprints, the blunders of scribes, or the mistakes of compositors in deciphering the illegible manuscripts of authors. Such words have been well designated by Professor Skeat as Ghost-words. But Professor Skeat has said nothing about what may be called Ghost-names, which are, perhaps, more numerous than Ghost-words, inasmuch as in a manuscript, however badly written, the context gives some clue to an undecipherable word, whereas in the case of a name there is no such aid. Hence we find on our maps not a few names which are properly not real names, but merely blunders which pass for names.

Not long ago I happened to be present at the birth of a Ghost-name. Crossing the Bay of Biscay from the south in one of the boats of the P. & O., a passenger inquired when we should pass Cape Quessant. Never having heard of such a cape, I asked him where it was. He took me into the smoking room, where a well-thumbed atlas, belonging to the ship, lay upon a table, and he pointed to the name of Cape Quessant at the extreme western corner of Brittany. An examination of the map led to the removal of a tiny speck of dirt at the bottom of the first letter of the name, and Cape Quessant reappeared as Cape Ouessant, the usual French spelling of the name, often written Ushant in English books.

Several Ghost-names have arisen in this way from misreadings of the manuscripts of classical writers. In Scotland we have three such names, those of the Hebrides, the Grampians, and Iona. The Western Isles of Scotland are called the Hebrides, a name which has been transferred by Captain Cook to the New Hebrides in the South Pacific. Much fruitless ingenuity has been expended in the attempt to discover the etymology of the name. The explanation is very simple. Before the introduction of the dot over the letter *i* in the eleventh century, the letters *ri*, in the Caroline Minuscule, resembled greatly the letter *u*. Two early editions of Pliny's "Natural History" were printed from a manuscript in which the name Hæbudes appeared as Hæbrides, and hence Hæbrides was accepted as the ancient name of the Western Isles. That the reading was erroneous is shown, not only by better manuscripts, but by a notice in Solinus, who speaks of the *Hebudes insulæ quinque numero*, and the islands are called Ebudæ by Ptolemy. The Ebudes were doubtless so called because they lie around the island of Ebuda, now Bute, which is the nearest to the mainland, and would therefore be the first to become known to the Romans.

The second Scotch Ghost-name is that of the Grampians, which is given to the backbone of Scotland, extending from Ben Nevis to Ben Lomond. The old and correct Gaelic name was "Drumalban," the *Dorsum Albaniæ* of Latin writers. This use of the name Grampians contains a double blunder. Tacitus, in his "Life of Agricola," chapter 29, describing the victory of the Romans over Galgacus, tells us that the Caledonians were posted on a hill, which in all the best manuscripts appears as Mons Graupius. In one manuscript of small value, this name Graupius appears as Grampius. The Scotch historian, Hector Boece, who died in 1536, was the first to transfer this misread name from the rising ground on which the battle was fought to the central ridge of Scotland. The blunder was perpetuated in the celebrated forgery published in 1747 by Dr. Bertram, with the title *De Situ Britanniæ*, professing to be the work of Richard of Cirencester, a monk of St. Peter's Abbey, Westminster, who died in 1400; Bertram having doubtless made use of the history of Boece in compiling his work. Till Professor Mayor's detection of the forgery, Richard of Cirencester was supposed to be one of the best authorities for early English geography, and the book was freely used by Gibbon, Lingard, and other writers. Hence the double blunder of transferring a misread name from a small hillock to the great mountain

chain of Scotland has become so firmly rooted that it seems impossible to alter the usage.

Too firmly established to be now displaced is the name of Iona, the little island on which St. Columba founded the monastery which was to be the mother church of Scotland, and from which Irish missionaries went forth to convert the heathen nations of England, Germany, and Switzerland. But this name Iona originated, as Dr. Reeves has proved, in the blunder of a copyist. The island was called I, Hii, Ia, or Iou, "the island," whence we have the Mediæval name I-colm-kill, the "Island of St. Columba's cell." Adamnan, in his "Life of St. Columba," speaks of Ioua Insula, using the adjectival Latinized form Ioua for Iou. Some copyist, mistaking, as he easily might do, the *u* for *n*, wrote Iona Insula for Ioua Insula, and hence the island now appears on every map as Iona.

There are many names on our maps which have arisen from natives not understanding the questions put to them by inquiring travellers. Asking the name of some conspicuous object, a mountain or a river, the native guide replied in his own language "I don't know," or "I don't understand you," phrases which have been forthwith jotted down on the map as the name of the mountain or the river. Thus the name Yucatan, discovered in 1517 by Hernandez de Cordoba, was long supposed to be the native designation of the country. The native name, however, is Maya, and Yucatan is evidently a Ghost-name. Now in the Maya language *tectican* means "I don't understand you," and *jucatan* means "What do you say?" Evidently the name Yucatan must have arisen from one of these answers, probably the latter, being given by the native who was questioned by Hernandez as to the name of the country.

The vast State of Texas, whose area is greater than that of France and England put together, also bears a Ghost-name of similar origin. When Father Damian visited the coast at the end of the 17th century he asked a chief of the native tribe of the Assinaes who they were. The chief, misunderstanding him, replied *texia*, a "good friend," which Father Damian supposed to be the tribal name, and hence the Assinaes came to be called the Texas Indians, and this imaginary tribe-name was adopted as the name of the territory.

The name of the great Canadian dominion is also believed to have originated in a misunderstood answer to a misunderstood question. When Cartier, the French explorer, first sailed up the St. Lawrence, it would seem that, stretching out his hand, he asked a native the name of the country. He replied "Canada," a name by which the country has since been known. We now know that *Kanata* is a Red Indian designation for a village, or collection of wigwams, and the native must have thought that Cartier had pointed to some group of huts, and had asked what it was called. Canada, therefore, is itself a Ghost-name. Or take the name of the great State of Indiana. It was so called because it had been a reservation for the Red Indians. The American aborigines acquired the name of Indians because Columbus, when he discovered the New World, imagined that he had reached some islands lying off the coast of India, which he called the "Antilles," a Spanish word, meaning the "islands in front," being supposed by him to be islands lying in front of India. Hayti he identified with Japan, and Cuba with China. Columbus died in the belief that all the lands he had discovered belonged to Asia; and the delusion long survived. Thus there is a village near Montreal called "La Chine" (China). It bears the name of a house so called, erected by La Salle in 1666, which he named "La Chine," in the belief that the Mississippi, which he was preparing to explore, flowed into the Pacific, and that it would be possible, by descending it, to reach China and Japan.

Even the name America may almost be called a Ghost-name, certainly so in the sense in which citizens of the United States call themselves "Americans." Columbus believed that some of the lands he had discovered formed a part of India, and hence they received the names of "India Major" (Greater India), or of "Indias Occidentales" (the West Indies), which still cleaves to the islands where Columbus first touched land in 1492. Five years later, in 1497, the Englishman John Cabot reached Newfoundland, which he called "Prima Vista," the land "first seen," and he then coasted southwards as far as Florida. Hence the name of Newfoundland, which he gave to the continent he had discovered, was long used in England to denote the whole of North America, till at length it was restricted to the land first reached by Cabot. In 1500 the Portuguese, under Cabral, reached South America, which was named "Terra da Santa Cruz" (the "Land of the Holy Cross"). A few years later South America acquired the name of "Terra do Brazil," the land of a dye-wood, *brazil*, so called because it produced the colour of glowing charcoal (*braza*). According to Amerigo Vespucci's own account, he sailed, in a subordinate capacity, between 1497 and 1504, with an expedition which discovered a small part of the coast near the mouth of the Orinoco. What part (if any) Amerigo Vespucci took in the discovery of the New World is still a matter of controversy. However, in a book on geography, published in 1507, the name of "Americi Terra" (the "Land of Americus") was proposed by Waldseemüller for that portion of the coast which Vespucci claimed to have visited, but at this time it was not known that North America, or, as it was then called, Newfoundland, belonged to the same continent—in fact, a strait is shown on early maps in place of the Isthmus of Panama. This form, America, is found on a map published in 1522, but the name seems to have been unknown to Girava, a Spaniard, who observes in his "Cosmographia," published in 1570, that India, or the "New World," was called by some persons "India Major" (Greater India), to distinguish it from "India Oriental," or "East India." The name of America, as a designation of the New World, seems to have become popular mainly owing to its adoption in the great atlas of Ortellius, published in 1570. Even in 1608, Acosta, in his "History of the Indies," prefers the old Spanish name of the Indies to the new term America. Thus it appears that for about a century the five names, Newfoundland, the Indies, Brazil, the New World, and America struggled for existence, the ultimate choice of the name America being largely due to the supposed fitness of a name analogous to those of the three continents of the Old World.

The name of Australia, the last of the continents to be discovered, also arose out of a strange misconception. The early geographers supposed that the two hemispheres must contain a nearly equal quantity of land, in order to prevent the world from overbalancing by reason of the greater weight of the Northern Hemisphere. Hence they placed on their maps a vast conjectural southern continent which they termed Terra Australis Incognita, the "undiscovered southern land." When at last Australia became known, the Terra Australis Incognita became Terra Australis, and it was only in 1814 that Flinders, in his book entitled "A Voyage to Terra Australis," modestly observes in a footnote: "Had I permitted myself any innovation upon the original term, it would have been to convert it into Australia, as being more agreeable to the ear, and an assimilation to the name of the other great portions of the earth." The suggestion of

Flinders has, however, happily been adopted, and is a more rational name than those of Europe, Asia and Africa, which originally denoted only three small plains: the plain round Thebes, the plain round Ephesus, and the plain round Carthage.

(To be continued.)

SOME PRACTICAL APPLICATIONS OF ELECTRICITY.

By J. J. STEWART *(formerly Demonstrator of Physics at University College, London).*

(Continued from page 175.)

III.—ARC LAMPS.

ABOUT the year 1802, Sir Humphry Davy, by sending an electric current from a powerful voltaic battery of 2000 cells through two sticks of wood charcoal placed a short distance apart, obtained a brilliant discharge between the two charcoal points. The rush of Electricity produced a bright stream of light, shaped like a bow, in the interval between the ends of the charcoal, and hence the name of "Voltaic Arc" was given to it by Davy. Some years later he exhibited the effect before an audience at the Royal Institution. Of course, the soft charcoal was rapidly disintegrated, and from this cause, and also on account of the great expense at which it was produced, when the battery of cells was the only available means of generating the current, this first example of the electric light could not be applied to any practical or commercial use.

It was only when the introduction of dynamo machines rendered possible the production of powerful currents at comparatively small cost that there was any prospect of Electricity being used for purposes of illumination. Those to whom we owe the first production of the electric arc do not seem to have had much expectation that it would prove a general means of obtaining artificial light, and in a description of the voltaic arc, published so late as the year 1880, it is described as painfully, and even dangerously intense, and is said to dazzle rather than illuminate.

When a strong current of Electricity forces its way across a gap in a metallic wire which it is traversing, the air in the space between the ends of the conductor, opposing as it does a great resistance to the passage of the current, is raised to a very high temperature, minute particles of the metal of the wire are driven off, and these, with any dust which may be in the air, are raised to a white heat, and thus a luminous bridge is formed between the two broken ends of the wire. The heat generated in a conductor in a given time by the passage of a current of Electricity is proportional to the square of the current and to the resistance of the conductor. When the current remains the same the heat produced varies simply with the resistance. In the above case the resistance of the wire conveying the current is small, while that of the air gap is very great; thus there is little heat developed in the wire itself, but at the break in the circuit where the current passes through air the heat developed is very great, being sufficient to make white-hot the air and metallic vapour in its path. No metallic conductors would be durable enough to allow of a permanent arc being set up between them; it is only with an infusible substance such as carbon that this can be done. The source of the light in the electric arc is in the incandescent particles of carbon driven off from the carbon poles. The first step in the progress to the useful application of the arc was the employment of hard carbon, taken from the deposit which forms inside the gas retorts during the manufacture of coal gas. Pencils of this material employed instead of Davy's soft charcoal gave a much more permanent arc, but the light was still uncertain and liable to much flickering, owing to inequalities in the substance of the carbon.

The voltaic arc is not an example of disruptive discharge, as in the case of the spark from an ordinary electric machine or Leyden jar, but seems rather to be an instance of conduction, the air at the high temperature to which it is raised becoming a conductor of Electricity. Thus, also, when once the arc has been started between the carbon points, they may be removed to a greater distance apart without the disappearance of the arc. The passage of incandescent particles of carbon from one terminal to the other can be shown by throwing a magnified image of the heated points on to a screen by means of a lens. On observing the image thus produced particles are seen to be traversing the arc, sometimes in one direction and sometimes in the other, but mostly from the positive to the negative carbon. The positive carbon wears away twice as rapidly as the negative one. Its end becomes hollowed out into a crater-like cavity, while the negative carbon preserves its pointed appearance. When the carbon points are placed in a vacuum, this difference in behaviour is more marked. The image of the points projected on the screen will also show the appearance of round globules at the sides of the glowing carbons; these are due to melted portions of silica and other impurities in the carbon.

The voltaic arc excels, both in temperature and brightness, all other artificial sources of heat, and, by its means, some of the most refractory substances, which had resisted all other attempts to melt them, have been fused and some volatilized.

However, a large proportion of the rays emitted do not affect the eye as light, and thus a considerable part of the energy in the arc is wasted for the purpose to which it is to be applied, that of illumination. In fact, we as yet know of no artificial method of economically producing energy in the form of waves of light; a notable portion of the energy we get seems necessarily expended in generating the dark heat rays, and those ultra-violet rays which do not produce the effect of light to our eyes. The only really economical light known where nearly all the energy is obtained in luminous waves, is that of the humble spark of the glow-worm; in this the heat is negligibly small and the luminous part marvellously great.

The arc, like other conductors conveying currents, is acted on by magnets, and by using a powerful magnet the arc may be driven out to one side and made to take a pointed form like a blow-pipe flame.

One of the principal factors in the production of a good and steady light from the voltaic arc is the use of carbons of a compact and uniform structure. The production of such carbons is the object with many manufacturers, most of whom observe considerable secrecy as to the actual methods they employ. In one form of carbon the stick is pierced along its length to form a tube, which is afterwards closed at one end and filled up by a solution of certain materials containing in suspension a fine powder of the same sort as that which composes the original rod. This is driven in under high pressure, and has as its result the displacing of the gases which are contained in the carbon, and which it is important to remove. The hollowed carbon rod is in this way by degrees filled up, and at length a very compact sort of carbon is obtained.

As an example of the methods used to obtain a suitable carbon, the process employed in the manufacture of Carré's

carbons, which are amongst the best, may be mentioned. These carbons are made from the following ingredients: 15 parts of pure very finely powdered coke, 5 parts of calcined lamp black, with 7 to 8 parts of a syrup made from cane sugar and gum. This mixture is made into a paste with water, pressed, and then forced through a die which gives to the rods the form and size required; afterwards they are repeatedly baked at a high temperature. After one baking the rods are plunged into a hot and concentrated syrup of sugar, in which they are left some time, taken out and again immersed until they are thoroughly saturated with the liquid. After washing and drying, a similar process is gone through again until the carbons are as dense as is required. They are then dried for a prolonged period in stoves, the result being an excellent and tough form of carbon.

During the working of the lamp the two carbon rods gradually consume away, and the mechanism of the various forms of arc lamp is contrived to bring up and keep the carbon poles at the requisite distance from each other, so that a steady and unvarying arc may continue between them. As the positive carbon, as has been said, consumes away twice as fast as the other, it must be moved up towards the negative carbon with double its speed, and the distance between the carbon points must be kept approximately uniform. There are various devices in use for attaining this object, and without going into complete details, one of the forms of Crompton's lamp may be taken as a specimen. This is one of the examples which gives the best results and avoids the flickering, which is apt to be the great fault of arc lamps. In Crompton's apparatus, here described (which is one of his earlier forms, but may serve as an illustration of the general methods adopted), the weight of the upper carbon and its holder acts as a motive power, which sets a train of wheelwork in action, and causes the carbons to move towards each other in proportion as they are worn away by disintegration of the carbon points. The operation of "striking the arc" is the following:—The upper carbon descends through its own weight, touches the lower carbon, and the current passes through the circuit. In the circuit is an electro-magnet, and, as the current passes round it, this immediately attracts a plate of metal which has a spring attached to it, and this causes the train of clockwork, which was set in motion by the falling upper carbon, to set off in a reverse direction and raise the carbon again to a certain distance, thus forming the arc. When the arc has reached a suitable length and the current attained a certain strength, the spring attached to the armature of the electro magnet presses against a wheel in the clockwork and stops its motion. When the current becomes weaker owing to lengthening of the arc the electro-magnet also decreases in strength, and a spiral spring which is attached to its armature causes it to rise and leave the magnet, and this causes the stoppage of the clockwork and allows the carbons to come nearer together. As the length of the arc is constantly tending to increase as the carbons wear away, the clockwork is rarely at rest for more than a second or two at a time, but the ingenious device of the electro-magnet with its armature regulating the motion of the wheelwork insures automatic adjustment, and thus produces a satisfactory degree of steadiness. The regulation is self-acting, for the same current which produces the arc circulates round the coils of the electro-magnet, and the variations in the arc and the controlling magnet occur together. In other forms of regulating mechanism which differ in detail, the electro-magnet is placed in a shunt circuit, so that when the arc becomes too long and its resistance increases, more of the current goes round the shunt, strengthening the electro-magnet and causing it to act so as to produce the approach of the carbons.

Arc lamps are most suited for out-of-door illumination and for lighting wide areas. For indoor purposes the incandescent lamps are much preferable. The extent lit by these is more circumscribed and the light less intense, which is an advantage when they are to be used in houses. The applications of arc lamps to various purposes other than street-lighting are very numerous and increasingly so. Their use for lighthouse purposes, where the intensity and concentration of their light, as well as its space-penetrating power, renders them valuable, as also their application to photography, in which their richness in the chemical rays is very useful, may be mentioned. It is worthy of note that the immediate source of the light, viz., incandescent particles of carbon, is the same whether candles, oil-lamps, gas, or electric arc lamps are the means of illumination.

ON HUMAN PEDICULI.—I.

By E. A. Butler.

IF occasional parasites, such as fleas and bugs—creatures which simply visit our bodies at intervals, and spend only a small proportion of their lives actually on our persons—excite repugnance and disgust, what can be said of the feelings with which we contemplate those hideous pests that make men's bodies their life-long home, born and bred thereon, generation after generation, living there and there alone, and, as units of life, almost, if not entirely unknown, apart from such association? And yet, though cleanly people nowadays hold them in such utter abhorrence that they can hardly be named in polite society, they were not always objects of loathing and disgust. In former times people were more inclined to joke about them than to shudder at them, and some, it is said, even went so far as to be proud of their guests. In Hooke's "Micrographia," which, as we have already seen, was written some 230 years ago, there is a brief account of the head-louse, accompanied with an enormous figure representing a specimen magnified to the length of nearly two feet. Hooke introduces his description with the following highly suggestive passage:—"This is a creature so officious, that 'twill be known to every one at one time or other, so busie, and so impudent, that it will be intruding itself in everyones company, and so proud and aspiring withall that it fears not to trample on the best, and affects nothing so much as a Crown; feeds and lives very high, and that makes it so saucy, as to pull any one by the ears that comes in its way, and will never be quiet till it has drawn blood." Whatever we may think of the good taste of this passage, and the quaint conceit it contains, it is evident that personal cleanliness was not considered in the days of the Stuarts a matter of such vital importance as it has come to be regarded by respectable society in the Victorian era, and visions of the shady side of domestic life in the time of the "Merry Monarch" are called up, which it is as well to draw a veil over.

Man is not exceptional amongst mammals in harbouring these vermin, he is but in the same category with the rest; for it seems to be the rule, from elephant to mouse, largest to least, that some member of this group of parasites should be attached to each species, and even aquatic mammals, such as the seal and walrus, do not escape their attacks. But, just as the human flea is not

the same as those of other animals, so human lice are distinct from those which infest the lower mammalia, and indeed each species of mammal may be expected to have its own distinct parasite. Man, then, is not exceptional in *suffering* from these parasites, but rather in having to some extent, as has taken place amongst civilized nations, shaken himself free from them.

Of these disgusting insects three species are known to infest human beings, the head-louse (*Pediculus capitis*), the body-louse (*P. vestimenti*), and the crab-louse (*Phthirius inguinalis*). The first is the kind that occurs most commonly, and the last is the rarest. The two *Pediculi* are very much alike, the body-louse being best distinguished by the locality in which it is found, and by its larger size; the *Phthirius* is very different from both. Taking as our type the commonest species (Fig. 1), we may first note its structural peculiarities. It is a flattish, semi-transparent insect, of a pale ashy grey colour, with a comparatively small head and a very large body. The head, which is narrowed in front and behind, carries a pair of short five-jointed antennæ, a pair of simple, rounded, unfacetted eyes, and the mouth organs, of which more presently. Behind it merges into the thorax, which again is not definitely marked off from the abdomen, but the three pairs of legs show how far its three segments extend. The legs succeed one another without interval, and the first pair are placed immediately behind the head. No wings of any kind are ever developed, nor is any trace of such organs perceptible; hence some naturalists have questioned whether the lice should be included amongst insects at all. Not only is the thorax considerably broader than the head, but this increasing breadth is continued into the abdomen, so that the widest part of the insect is about half-way down the body. The margins of the abdomen show a scalloped edge, there being a series of indentations where the segments adjoin. On each of these rounded projections is placed a small circular spiracle, or breathing hole, the terminal orifice of a short tracheal branch. Six spiracles are thus arranged down each side of the body, and all the short branches from them join a great tracheal trunk which runs down each side parallel to the margin. The whole body is covered with minute scattered hairs, which are sharp-pointed and perfectly straight.

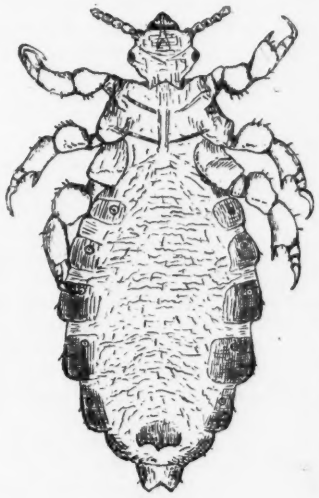


FIG. 1.—Head-Louse (*Pediculus capitis*). Female, viewed from beneath. Magnified 22 diameters.

The legs are composed of the usual parts, but all the joints are short and stout, giving an appearance of clumsiness, and the feet are extremely peculiar, their remarkable structure forming one of the distinctive characteristics of a louse. The tarsus, or foot proper, consists of two small joints, the division between which is not very easy to see, and these are succeeded by a terminal appendage in the form of a single, curved, movable claw of large size, which is usually carried bent more or less inwards, and is capable of being completely folded back upon the foot. At the end of the tibia, or shank, there is a movable pointed prominence, and by means of this, which acts as a sort of thumb, and the great claw, the insect is enabled to exercise that strong grasping and clinging power for which it is noted, and which is of great importance in its economy, facilitating its movements amongst the hairs in the midst of which its life is spent. In the figure one of the claws is shown bent back upon the "thumb," as in the act of grasping. The claws are very similar in shape to those of fleas, but differ in being single on each foot, instead of double.

In the structure of the mouth organs again, lice are exceptional. When the dead or inactive insect is examined, no mouth organs can be seen, for, when not in actual use, they are retracted within the head. The mouth is of the suctorial type, the insect feeding on the blood of its victims, to obtain which, an incision must of course be made through the skin. But, in consequence of its retractile character, there has been a great deal of difficulty in determining the real structure of the sucking apparatus, and it is necessary to carry out careful observations on the living or recently killed insect, before the details can be made out. The old Dutch naturalist Swamm erdamtook great pains in investigating the matter, and showed clearly that there was a suctorial proboscis, which could be thrust out from the head and entirely retracted again. But, as he himself says, "this proboscis is, on account of its diminutive size, not to be demonstrated except with great painstaking, and it is perhaps nothing but a piece of good luck if one succeeds in seeing it." This being the case, it is perhaps not surprising that since Swammerdam's time some authorities have denied the exclusively suctorial character of the apparatus, and have maintained that true biting organs are present, whence they attributed the irritation produced by the insects on their hosts to the effects of a real pinching bite. This, however, was a mistake arising from the fact that only dead specimens were examined, and those too under pressure, so that the apparatus could only be seen through the skin as it lay contracted inside the head, in consequence of which it was misinterpreted. About twenty-five years ago Professor Schiödte, a Danish naturalist, by careful observations on the living insect (in this case *P. vestimenti*), confirmed Swammerdam's statements, and determined with greater accuracy the true nature of the proboscis. He obtained an abundant supply of material from a workhouse (Danish), and having enclosed some specimens in a glass tube for two or three days without food, so that they might the more readily fall to when released from confinement, he transferred one of them to the back of his hand and prepared to watch its movements with a lens. He thus describes what followed:—"Scarcely does the abominable little monster feel the heat of the skin before it lays aside its former disheartened attitude, and begins to feel at ease, its antennæ oscillate for joy, and it stretches all six legs complacently out from the body. But though the pleasure and surprise at the sudden transportation into congenial surroundings for the first moment eclipse everything else, hunger soon asserts its claim, sharpened as it is by the long fast, which has rendered its stomach and intestines quite transparent. The animal raises itself on its legs, walks on a few steps, seeking and feeling its way with its antennæ, while we follow it with the magnifier. Presently it stops, draws in its legs a little, arches its back, bends the head down towards the skin at an oblique angle, while it pushes a small dark and narrow organ repeatedly forward, and

draws it back through the fore end of the head; at last it stands still, with the point of the head firmly abutted against the skin." While the animal was in this position he seized it gently with forceps, and endeavoured to detach it from the skin, hoping thus to see the extended proboscis. But in this he was disappointed, for though a slight resistance to his efforts was experienced, showing that the proboscis had really penetrated the skin, yet when the insect was detached, no trace of a proboscis, or anything of the sort, could be seen; it had instantly shot back into the head, and returned to the normal position of rest. This method therefore having proved ineffectual, the experimenter decided for a time to confine his observations to the upper surface of the insect during the progress of its meal, so as to watch, through the transparent skin, the gradual drinking in of the blood. Allowing it therefore to attach itself once more, he sees "at the top of the head, under the transparent skin, between and a little in advance of the eyes, a triangular blood-red point appear, which is in continual movement, expansion and contraction alternating with increased rapidity. Soon this pulsation becomes so rapid that several contractions may be counted in a second." Swammerdam also had noticed this, and likened the rapid movements of this little pumping machine to the quick oscillation of the balance-wheel of a watch. Schiödte continues, "the whole digestive tube is now in the most lively peristaltic movement, filling itself rapidly with blood, as is easily observed: the long œsophagus is particularly agitating, throwing itself from one side to another inside the neck, bending itself so violently as to remind one of the coiling of a rope when being shipped on deck."

Fig. 2.—Proboscis of Body-Louse. (After Schiödte.)

The insect was now thoroughly hard at work, and this was therefore the opportunity for the next stage in the proceedings. In order to prevent the retraction of the proboscis which would have followed the withdrawal of the insect, the experimenter determined to decapitate it suddenly, hoping that thereby the proboscis might remain extruded. The fore part of the insect was therefore rapidly severed with a pair of fine scissors without previously disturbing it in its feast. The decapitated head, having been left as it was for a short time, was then gently raised with forceps, and the proboscis gradually withdrawn; the whole was then transferred to a slip of glass and placed under the microscope without pressure. The appearance presented was such as is shown in the accompanying diagram (Fig. 2). A long fleshy tube was depending from the mouth, at its base was a stouter part furnished at its apex with a number of hooks, but the rest of the tube was thin, flexible and transparent. Within the latter could be traced four thin chitinous bands, the representatives of the two pairs of jaws, the mandibles and maxillæ of the ordinary insect's mouth. Thus we have an arrangement resembling in some degree that of the mouth of the bed-bug and other Hemiptera, a tubular labium containing four setæ, the mandibles and maxillæ. During the process of the extrusion of this apparatus the first part to appear is the strong base of the tubular labium, but the hooks are at first inside the tube. They can, however, be everted, and by a continuance of the same process the membranous lining of the tube is brought out and forms the long delicate sucker which constitutes the greater part of the proboscis. The labium having been inserted into the skin, say through a sweat pore, the hooks become everted and hold the proboscis steady by clinging to the tissues around. The piercing mandibles are then thrust out; towards their tip they are united into a tube from within which the second pair of setæ is protruded, similarly united, and terminating in four small lobes, which seem to act as feelers. All this mechanism can be thrust out to varying distances, and hence the length of the exserted proboscis can be accommodated to the thickness of the skin of the victim in the particular place in which the animal is feeding; by this means the capillaries of the host are at length reached, when blood will at once ascend the proboscis, the flow being accelerated and continued by the vigorous action of the pump-like cavity in the digestive tube already mentioned.

But to return to our decapitated head. The observer, wishing to examine the structure of the proboscis under a higher power of the microscope, put it under pressure for that purpose, when instantly the whole apparatus shot back into the head, and no further observations could be conducted; in this position the two sides of a chitinous band marked *a* in the diagram look something like biting jaws, and had been mistaken for such by those who had not seen the protruded instrument. These appear as a dark band across the under surface of the head in Fig. 1, which was drawn from a specimen prepared for the microscope, and therefore more transparent than usual, and beneath them the outlines of the retracted proboscis can be traced. Schiödte had to carry out many other observations on specimens prepared in a variety of ways before the whole of the details enumerated above could be determined, and whoever wishes to verify these results must be prepared to exercise great patience in the investigation. Leeuwenhoek was so much struck with the beauty and delicacy of this feeding apparatus, even so far as it was known in his time, that he appeals to its complex character as evidence that a creature which possesses so elaborate a sucking pump could not have been, as was formerly believed to be the case, spontaneously generated from "dirt, sweat, or excrements," but must have an origin similar to that of more highly organized animals.

(To be continued.)

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of Knowledge.

Dear Sir,—I beg to enclose for insertion in your paper what I claim to be a fresh discovery in figures, should you think it worthy of your notice. How to tell by inspection whether a number is or is not a perfect square or a perfect

cube is made much easier by knowing the following rule:—"If the sum of the digits in its simplest form equals any of the following numbers it cannot be a perfect square, *i.e.*, 2, 3, 5, 6 and 8; and the number can only be a perfect cube when the sum of its digits, reduced to its simplest form, equals one of the numbers 1, 8 or 9." It is also an interesting fact that the sum of the digits of the squares of consecutive numbers recur in the following order—1 4 9 7 7 9 4 1 9, and similarly the sum of the digits of perfect cubes recur in the order 1—8—9.

EXPLANATORY TABLE.

Number.	Cube.	Sum of digits.	Number.	Cube.	Sum of digits.
1^3	1	1	7^3	343	10=1
2^3	8	8	8^3	512	8
3^3	27	9	9^3	729	18=9
4^3	64	10=1	10^3	1000	1
5^3	125	8	11^3	1331	8
6^3	216	9	12^3	1728	18=9

And so on *ad infinitum*.

Number.	Square.	Sum of digits.	Number.	Square.	Sum of digits.
1^2	1	1	10^2	100	1
2^2	4	4	11^2	121	4
3^2	9	9	12^2	144	9
4^2	16	7	13^2	169	16=7
5^2	25	7	14^2	196	16=7
6^2	36	9	15^2	225	9
7^2	49	13=4	16^2	256	13=4
8^2	64	10=1	17^2	289	19=10=1
9^2	81	9	18^2	324	9

And so on *ad infinitum*.

Yours faithfully,

London, 3rd November, 1891. A. W. GORDON.

[Mr. Gordon's note may interest some of our readers. His test for cube numbers is so obvious from theory that he is probably mistaken in regarding it as a fresh discovery. The test is useful, as it enables the cube hunter to discard two-thirds of the numbers which may come before him, and Mr. Gordon's test for square numbers enables him to discard five-ninths of the numbers he may have to deal with, but it is not as easy to remember as the well-known test already referred to in KNOWLEDGE by Mr. Christie and Mr. Barrett, viz., that numbers which are perfect squares cannot end with the digits 2, 3, 7 or 8, but both of the tests for square numbers may be applied successively.

Mr. Gordon's test for cube numbers follows from the fact that all perfect cubes are either multiples of 9, or when divided by 9 a remainder which is either 1 or 8 is left. When the number is divisible by 9 the sum of its digits is equal to 9, and when the remainders 1 or 8 are left the sum of its digits must be either 1 or 8. The rule with regard to the division of cube numbers by 9 follows directly from the fact that a number which is divisible by 3 must when cubed be divisible by 9, while a number which is divisible by 3, leaving a remainder 1, must when cubed and divided by 9 leave a remainder 1, for

$$(3n+1)^3 = 3^3 n^3 + 3.3^2.n^2 + 3.3.n + 1$$

which must be a multiple of 9 plus 1, and a number which is divisible by 3, leaving a remainder 2, must when cubed and divided by 9 leave a remainder 8, for

$$(3n+2)^3 = 3^3 n^3 + 3.2.3^2 n^2 + 3.2^2.3.n + 2^3$$

which is a multiple of 9 plus 8.

Mr. Gordon's test for square numbers follows from the fact that to pass from the square of any number n to the square of the number immediately above it we must add $2n + 1$, or what amounts to the same thing, the square of any number n may be found by adding together the first n terms of the series $1+3+5+7+9+11+$&c. The sums of the digits of consecutive numbers recur in the order 1, 2, 3, 4, 5, 6, 7, 8, 9; therefore, if we pass along this recurring series with steps of increasing length, beginning at 1 and stepping 3 intervals at the first step, 5 at the second, and so on, we shall step from the sum of the digits of one square to the sum of the digits of the next, and shall always avoid the numbers 2, 3, 5, 6 and 8, for they are avoided in the first eight steps, and afterwards the same numbers are avoided because the subsequent steps are similar to the first eight steps, except that they are each eighteen intervals longer, and eighteen intervals corresponds to two complete circuits of the recurring series. Thus the sums of the digits of the squares of successive numbers are marked with a point above them:—

1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4

5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3

A. C. RANYARD.]

SNAKE POISON.

To the Editor of KNOWLEDGE.

SIR,—Two years and a half ago you were good enough to open your paper to a discussion between Mr. Field and myself on the subject of experimenting on animals with snake poison. Mr. Field, who had performed in France some mild experiments on mice in this line of research, took occasion in writing for you on the "Common Adder," to make the following remarks:—

"When we think of the thousands of our fellow men who die annually by reason of our want of knowledge with respect to snake poisons, the importance of experimenting on living animals (*for by these means alone can an antidote be found*) in this case cannot be over-estimated. . . . We may truly say then, that he who hinders the progress of such investigations commits a sin against mankind."—KNOWLEDGE, February, 1889.

Naturally I protested against this view, and asserted that "he who, for the sake of remote and doubtful physical benefits to our race, encourages a practice which unquestionably must stifle the impulses of compassion in the human soul, is the real sinner against mankind." I also quoted the *Encyclopædia Britannica*, vol. xxii., p. 191, to contradict Mr. Field's statement, "an antidote has been discovered," the *Encyclopædia* elaborately explaining that "*no* antidote is known capable of counteracting or neutralizing the action of snake poison."

After two years my contention has been so remarkably confirmed that I must ask your permission to refer your readers, who may take interest in the controversy, to no less an authority than the columns of the *Lancet* (October 24th, p. 960), for the fullest satisfaction on the subject. They will there learn that "a country practitioner at the Antipodes discovered the antidote and for years practised it with unfailing success, when Feoktistow, *misled by his experiments*, rejected it." Mueller's theory, derived from careful observation with *no* vivisectious experiments, has proved a true and vast benefit to humanity, while those experiments on animals which Mr. Field asserted were the "*only* means" of discovering an antidote, not only failed to result in such a discovery, but actually put the investigator on a wrong scent, and *prevented* him from finding what was before his eyes!

I am, Sir, truly yours,

FRANCES POWER COBBE.

[I do not agree with Miss Cobbe's interpretation of the paragraph in the *Lancet*, but I will ask Mr. Field to allow the lady to have the last word, as the controversy is not suitable for the pages of KNOWLEDGE, and must now come to an end.—A.C.R.]

XUM

To the Editor of Knowledge.

Sir,—At page 192 of the October issue you say: "Everyone is familiar with the earth-smell of the air after a shower of rain, when the lowered pressure of the barometer allows the air which has been forced into the soil to rush back to the surface." Being a very early riser, and fond of working in the garden, one of my daily pleasures at this time of the year—often before daylight—is watering the flowers. The "earth-smell" you speak of is very familiar to me, and all through our hot summer weather (practically *rainless*) its pleasant, refreshing odour is one of the satisfactions of my morning work. Let me ask if it is not likely that some chemical process may be the cause of the grateful aroma, for how, in the instance I speak of, could lowered barometric pressure find place as a cause? If I water in the evening, and the ground is damp when I renew work in the morning, no earth-odour is perceptible. Yours obediently,

Charles F. Hart.

The Oaks, Claremont, California,
October 16th, 1891.

[I do not remember to have noticed the earthy smell except after a shower of rain. No doubt it is due to some chemical change which takes place on the contact of air with freshly wetted earth.—A.C.R.]

THE UPPER ATMOSPHERE.

To the Editor of Knowledge.

Sir,—Your article in Knowledge under this title makes me wish to ask if it is not possible that the earth in times long past gradually robbed the moon of her atmosphere?

You state that a velocity of 7 miles per second would carry gaseous molecules right away from the earth's upper atmosphere into space.

What speed would carry such molecules *from the moon to the earth?* and is such speed possible or probable?

A note in Knowledge on this question would I think be of general interest. Yours respectfully,

W. M.

P.S.—If the moon used to be much nearer the earth, as Prof. Ball has supposed, and if her recession was slow, what effect would that have on the supposed gaseous-robbing powers of the earth?

[A velocity of a little more than $2\frac{3}{4}$ miles per second would be necessary to carry a projectile shot vertically upwards from the moon's surface out of the region of the moon's attraction. This is so much greater than the mean velocity of the molecules of our atmosphere at temperatures such as probably exist on the moon, that it seems improbable that the most swiftly moving gaseous molecules could escape from the region of the moon's attraction. If in the earlier stages of the moon's history the moon and earth ever had a common atmosphere it seems more probable that the moon would have robbed the earth of its atmosphere rather than that the earth should have robbed the moon. For the moon, by reason of its greater surface compared with its mass, must from a very early stage have cooled faster than the earth, and the cooler body would, under such circumstances, tend to rob the hotter, as the gases would condense upon it while they still formed a lofty atmosphere about the hotter body. Whatever was the initial condition, there must have been a great evolution of gases during the formation of the lunar volcanoes. Our own geologic history shows that there has been a continual evolution and absorption of gases by terrestrial rocks, and probably similar changes have taken place upon the moon.—A. C. Ranyard.]

DARK STRUCTURES IN THE MILKY WAY.

By A. C. Ranyard.

THE first plate which illustrates this paper has been made from a photograph taken by Dr. Max Wolf, of Heidelberg, with an exposure of eleven hours seven minutes made on three different nights, viz., the 11th, 12th, and 13th September, 1891.

It represents a region of the Milky Way in the constellation Cygnus on the following, or eastern side of the region represented in the large plate published in the October number of Knowledge. The nebulous star α Cygni, which was near to the centre of the plate in the October number, is here seen near to the edge of the plate on the right hand or "preceding" side. Vertically above α Cygni the dark branching structure, an outline of which is given in Fig. 1, will easily be recognized. The reader may assure himself that this tree-like structure is not due to a photographic defect by comparing the plate in the October number with this plate, as well as with the right-hand picture on our second plate, which is a photograph on a much smaller scale of the same region, but includes a greater area of the heavens. This latter photograph was taken by Dr. Max Wolf in a small camera fixed upon the top of the large camera, and driven by the same clock motion. The two cameras were rigidly attached to a telescope, which enabled the driving of the clock to be controlled and the cameras to be accurately directed to the same region of the heavens from night to night. The accuracy with which this has been done is attested by the photographs obtained; even the smallest stars shown are represented by minute white patches, which appear approximately circular, though our plates are enlarged more than two diameters from the original negatives.

Fig. 1.—Diagram showing small dark tree-like structure to the north of α Cygni.

Our first plate, representing the region about ξ Cygni, was taken with the $5\frac{1}{4}$ inch Kranz aplanatic camera, described in the October number, and the right-hand picture on our second plate was taken with a smaller camera fitted with a portrait lens of only 55 millimetres (about $2\frac{1}{3}$ inches) aperture and 195 millimetres (about 7·8 inches) focal length. The photograph taken with this small camera will bear examination with a lens, and a comparison of it with our first plate and the plate published in the October number is most instructive. The tree-like structure represented in Fig. 1 will be distinctly recognized in all three photographs as darker than the surrounding area. It evidently corresponds to a branching stream of matter which cuts out the light of a nebulous background on which it is seen projected, and it is evidently intimately associated with the lines of stars which border the stream and its branches on either side. In addition to the large stars which lie along the edge of the dark area, lines of very minute stars may be traced within the dark structure—they seem to fall into lines conformable to the main stream and branches. A somewhat similar dark branching stream may also be traced on the photograph of the ε Cygni region in the October number. One of its branches runs close to ε Cygni, and passing northward again branches. The structure represented in Fig. 1 seems to be connected at its base

XUM

The Region of the Milky Way about ξ Cygni.

Enlarged from a photograph taken by Dr. Max Wolf, of Heidelberg, with a Kranz Aplanatic Camera of $5\frac{1}{4}$ inches aperture, and a focal length of $30\frac{1}{3}$ inches; exposure 11h. 7m.

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with a dark channel, which runs for a considerable distance east and west, that is horizontally, on the plate.

Fig. 3, made from Mr. Cottam's "Constellation Atlas,"

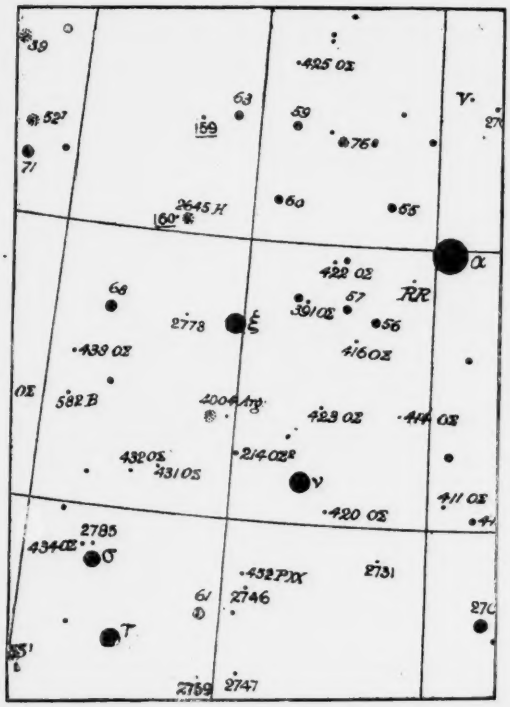

FIG. 2.—Index Map made from Mr. Co''am's map of the ξ Cygni region.

will enable the reader to identify the names of the principal stars shown in the ξ Cygni plate. Fig. 3, which was made by a photographic process from the α Cygni photograph published in the October number, half overlaps the region comprised in Fig. 2, and is interesting to compare with it. It will be seen that the photographic magnitudes often differ considerably from the magnitudes as seen with the eye and given in Mr. Cottam's map. ξ Cygni will be identified as lying in the middle of a dark channel to the east (or left-hand side) of a conspicuously bright nebulous region which tapers away towards the south, and reminds the casual observer of the outline of the continent of North America.

ξ Cygni is classed by Prof. Pickering in his spectroscopic catalogue as having a spectrum of the K or solar type, while α Cygni, which is involved in nebulous haze, is classed as having a spectrum of the same type as Sirius crossed only by the broad hydrogen lines. γ Cygni, which is also involved in nebulous haze, is noted by Prof. Pickering as exhibiting a very peculiar spectrum, containing several bright as well as dark lines. 61 Cygni, our second nearest neighbour amongst the stars, will be seen near to the bottom of the ξ Cygni plate. It forms the apex of a roughly equilateral triangle, of which σ and τ Cygni form the extremities of the base. 61 Cygni is drifting at the rate of $5\frac{1}{5}$ seconds per annum in a direction which will carry it a little to the north of σ Cygni in a little less than three thousand years. It will readily be understood, therefore, that photographs on this scale are not suitable for detecting the parallax of stars, or even for detecting the proper motions of the more swiftly moving stars. Prof. Pickering ranks the spectrum of this interesting pair of stars,* which have not yet been proved to form a binary system, in his Class H, which is one of the divisions of the solar type of spectrum.

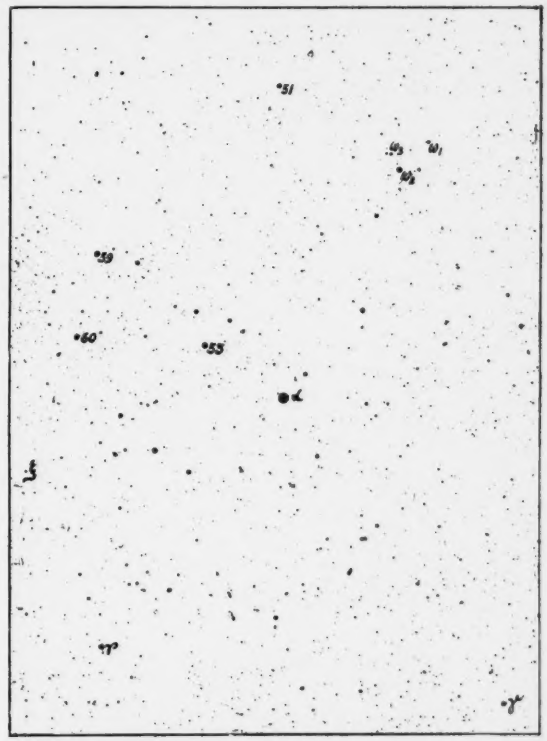

FIG. 3.—Index Map made by a photographic process from Dr. Max Wolf's photograph of the α Cygni region.

Professor E. C. Pickering's catalogue, although it contains details with respect to the spectra of over ten thousand stars, does not profess to classify with any certainty the spectra of stars less than the 6·5 magnitude. We are therefore unable to say what is the type of spectra of the numerous stars involved in the nebulous region, or even whether the nebulous masses give continuous or gaseous spectra. But most of the stars involved in the brighter nebulous region appear relatively larger on the photographs than they do to the eye, which gives rise to a presumption in favour of their possessing spectra of the first, or *Sirian* type. Thus, ν Cygni, 55 and 56 Cygni, and σ and λ Cygni all possess spectra of the Sirian type, and all appear relatively larger on the photographs than they do to the eye or in the telescope.

On the eastern or following side of the bright nebulous patch, the outline of which is given in Fig. 4, is a dark channel with fainter projections extending from it on either side. This dark structure seems to have some analogies with the dark arch shown in Mr. Barnard's

FIG. 4.—Diagram showing dark structure evidently in front of nebulous mass near ξ Cygni.

* They are too close to give separately observable spectra.

photograph of the Sagittarius region. The picture of the Sagittarius region on our second plate does not show Mr. Barnard's dark arch as well as the pictures published with the August number of KNOWLEDGE, 1890, or the denser pictures published in the "Old and New Astronomy," plate xxviii, but there is no doubt about its existence, or the existence of the prominence-like structures which spring from its eastern or convex side. As remarked by Mr. Barnard in the paper accompanying his photographs (published in the *Monthly Notices*, vol. L., p. 314), this dark lane or arch amongst the stars seems to be intermediate in distance between the different bright structures shown upon the plate. It evidently lies in front of the bright structures shown on the lower and upper parts of the plate, and seems to be crossed or broken in upon by one of the bright structures at *A*.

Fig. 5 is an index map which indicates the position of

FIG. 5.—Diagram indicating the position of dark tree-like structures traceable on Mr. Barnard's photograph of the Sagittarius region.

two dark tree-like structures, C and B, which both seem to spring from the dark region D at the bottom of the Sagittarius plate. From this same region also springs the bright tree-like structure indicated in outline in Fig. 6. The dark structure C seems to lie in front of the bright tree-like form shown in outline in Fig. 6. This bright tree-like form, as well as the dark structures B and C, all seem to have had their origin in the dark region D, and to indicate the existence of colossal outrushes of matter into a resisting medium.

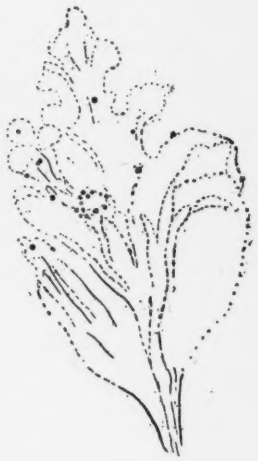

FIG. 6.—Diagram showing outline of bright tree-like structure, visible on photograph of the Sagittarius region.

Like the comparatively small dark structure indicated in Fig. 1, these larger dark structures seem to be associated with bright stars which lie along their borders, though the stars are not arranged in such definite lines or streams along the edges of these large dark regions as they are along the borders of the narrow dark channels, and smaller tree-like structures such as that shown in Fig. 1 and at the summit of C, Fig. 5. It will be noticed also that the dark region at the bottom of the plate is bordered by two conspicuous star clusters. The dark regions in the trifid nebula are also bordered by lines of stars, and the dark patches or holes in the Milky Way, referred to in the October number (a striking example of which is shown in Mr. Barnard's photograph), are surrounded by circles of stars. It is evident that there must be some intimate connection between the dark regions, or the absorbing matter they contain, and the stars surrounding them. In the case of the solar prominences we know that the tree-like forms are due to masses of glowing gas shot upward into a resisting medium; and it seems very probable that the tree-like structures of the Orion nebula also consist of gaseous matter, for they are the brightest parts of the nebula, and the spectroscope shows that the chief part of the light of this nebula is emitted by incandescent gas. Have we, in the Milky Way, gaseous phenomena on a still more colossal scale?

Notices of Books.

Primitive Folk. By Elie Reclus (Walter Scott).—In this volume of the "Contemporary Science Series" we have an intensely interesting description of the manners and customs of some very little known nationalities, the Inoits or Esquimaux, the Apache Indians, and some of the hill tribes of India. Starting with the motto that "to travel over space is to travel over time," the author goes to the remote regions inhabited by these tribes in order to see man as one might expect him to have been in the youngest days of his history. Just as the embryologist reads something of the past history of a species by an examination of the phenomena the organism now presents in its earliest stages, so the ethnologist tries to recover something of the history of the progress of the human species by observations on those examples of it which are now in the most elementary condition. The idea is a fascinating one; indeed, as the author says, "certain customs, the meaning of which has never been suspected even by those who practise them, are in their own way as interesting as it would be to an archæologist to unearth a lacustrine city, or to a zoologist to discover a pterodactyl dabbling in an Australian marsh"; and its interest is still further enhanced by the keenness of perception which the author

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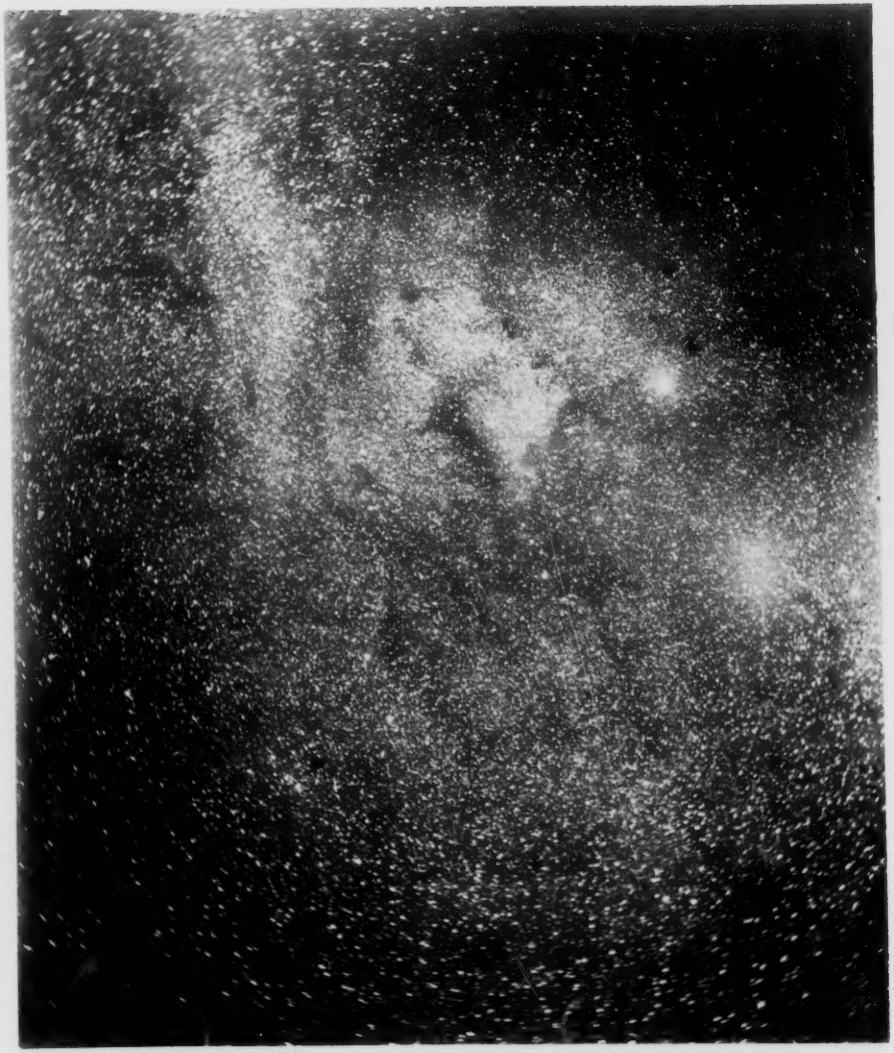


The Region of the Milky Way about ξ Cygni.

Enlarged from a photograph taken by Dr. Max Wolf, of Heidelberg, with a portrait lens and thirteen hours' exposure, on the 9th and 10th September, 1891.

Region of the Milky Way in Sagittarius.

From a photograph taken by Mr. C. E. Barnard. Centre of picture, R.A. 17h. 56m., South Dec. 28°. Scale 1 in.=nearly 2°.

The Automatic Engraving Company, Strode Road, Willesden Green.

frequently displays in detecting fundamental similarities in widely different customs. He deals chiefly with the subjects of marriage, government and religious rites, but the pictures he draws do not represent things as they now are, but rather as they were half a century ago, before civilization had tampered much with the tribes in question; for, as the author states, "scarcely any primitive folk are now in existence; soon there will be none." The pictures of savage life are often horrible and disgusting enough, completely refuting the pleasing theory of the "noble savage." But even in the most disgusting practices and the most degraded rites, M. Reclus again and again finds ideas similar to those that lie at the root of many of the most respectable institutions of the civilized world. However, as degeneration and decline are admittedly factors in human history as well as progress and growth, it does not always seem clear whether, in the strange customs of these so-called primitive races, we may not be dealing with deteriorated remnants of something that was once nobler and better, rather than with the initial stages of that which in other nations, and under a more favourable environment, has developed into modern civilization; whether we have not debased relics instead of undeveloped germs; whether in fact, the name *primitive* folk, if taken in its literal sense, may not possibly involve a begging of the question. But however this may be, there is no question that in the book before us we have a valuable and interesting contribution to the literature of ethnology, as well as a series of essays which will stimulate thought and encourage enquiry.

British Ferns. By E. J. Lowe, F.R.S. (Swan Sonnenschein and Co.)—This is the fern-book of the "Young Collector Series," and as a record of the distribution and variation of our British ferns it is a marvellous shilling's-worth, and represents an enormous amount of careful work. The author has aimed high, so high indeed that we are inclined to wonder where the "young collectors" are to be found whose wants will be exactly met by this little book. One of his chief aims appears to have been to illustrate the extreme flexibility of type which ferns exhibit, and in this he has certainly succeeded admirably. A very large proportion of the book is taken up with the enumeration and brief characterization of varieties of the different British species, amongst which the common hart's tongue attains the maximum of variation; to this species alone 28 pages are allotted for the description of upwards of 400 varieties. So much space is occupied with this exhaustive treatment of varieties that no room is left for such matters as the generalities of fern structure and development, the distinctions between ferns and other plants, &c., some of which one might fairly expect to find explained in a beginner's text-book, written on scientific lines. The fern collector who wishes to make use of this book must lay his foundations elsewhere, and when he has acquired a good general knowledge of his subject, he can use Mr. Lowe's help in the study of varieties to his heart's content. Some useful hints are added as to fern growing and collecting, and some remarkable varieties are nicely figured.

On Surrey Hills. By "A Son of the Marshes" (Blackwood and Sons).—No more delightful book has come from the pen of the Kentish naturalist who, under the above *nom de plume*, has so often charmed the readers of "Blackwood," than this collection of essays on Nature as she is to be seen in the wilds of Surrey. It seems strange to talk of wilds in connection with a county into which suburban life is so rapidly pushing its way; and yet, as none know better than those who have been there, within little more than an hour from the roar and din of the Metropolis there are to be found on the Surrey hills places as lovely and silent as though they were in the remote Highlands of Scotland, where some of the fast-diminishing wild fauna of our islands still flourish comparatively unmolested. These little visited, but lovely and picturesque, spots were for many years the arena of our naturalist's observations, and in this book, with the assistance of the editorial pen of Mrs. J. A. Owen, he has recorded his impressions in simple but vivid pictures which cannot fail to interest and delight the reader. The accuracy of his notes proves him a keen and patient observer, in ardent sympathy with Nature. He is never better pleased than when watching the wild creatures of hill and dale, roadside and stream. Bird, beast, fish, or insect, it is all one to him: he loves Nature for her own sake, and wherever life of any sort disports itself there is he to be found, early and late, playing the spy upon it, and enjoying to the full the novelties of the scene. There is an air of freshness and freedom about these realistic sketches that is quite exhilarating, while the genial spirit which pervades them, the strong human interest exhibited, and the frequent touches of humour, combine to make "A Son of the Marshes" a capital companion.

An Account of British Flies (Diptera). Part I. By the Hon. M. Cordelia E. Leigh and F. V. Theobald, B.A. (Elliot Stock). At last we are to have a popular book on British Flies. The authors aim at catering for the wants of the young student of Dipterology, and they hope to be able also to entice to their ranks some stray collectors from amongst the devotees of the more popular orders of Butterflies and Beetles. With a courage which deserves success, they have undertaken the herculean task of describing the enormous host of British Diptera, large enough in Walker's time, but greatly augmented since the publication of "Insecta Britannica," forty years ago. Six parts are to be issued annually; the first, which has just appeared, contains a concise sketch of fossil Diptera, an account of various classifications of flies, and descriptions of some species of fleas. Life-histories, especially of agricultural pests, are to be fully dealt with, and occasional illustrations are to be added; those in the present number are scarcely up to the mark, the figure of the human flea especially being decidedly unsatisfactory. The classification followed will be that adopted by Mr. Verrall in his recently published list.

EXPLOSIONS ON PETROLEUM VESSELS.

By RICHARD BEYNON, F.R.G.S.

THERE is probably no department of British industry that has developed with such phenomenal rapidity as the Petroleum trade, and so far as present appearances are concerned there is every prospect of it undergoing much further expansion. The earlier shipments to this country were conveyed in barrels, but the evolution of the tank steamer has completely revolutionized the economics of the Petroleum trade. It is proposed in the present paper to discuss the adaptability of existent methods of transit to the requirements rendered necessary by the over-sea conveyance of crude Petroleum with its accompanying inflammable vapours.

Crude Petroleum or Naphtha may be described as an inflammable liquid hydrocarbon, or rather as a compound of several hydrocarbons. According to some authorities these are three in number: $C_{14}H_{13}$, $C_{16}H_{16}$, and $C_{24}H_{22}$. Each of these compounds has a different boiling point, that of the last named being the highest. The ordinary Petroleum of commerce boils at the low temperature of 120° Fahrenheit, and is exceedingly volatile. Of the native

occurrence of this oil there is no need to speak, the names Petroleum, *rock oil*, and Naphtha (Persian *nafata—to exude*), being sufficiently indicative of its origin. There is probably no country in the world that does not possess Petroleum-bearing strata, but the comparative small expense with which the American and Russian springs can be worked keeps out from the market oils which cost more to obtain. The Russian oil trade is conducted on the simplest lines possible. Pipe lines are laid down to conduct the oil from the wells to the refineries. Thus between Balakhani and Baku there are some seven lines of cast-iron pipes of six inches diameter, and through these pipes there flows in a day 2,000,000 gallons of Petroleum. The process of purifying is a simple one, and merely involves the employment of a series of stills, each one of a higher temperature than the preceding one. In one of these stills the Petroleum loses a portion of its constituents, in one the more volatile oils, in another the paraffin; further on, the heavy lubricating oils, and last of all there is the "residuum," as it is styled in America, or "astatki" by the Russian distillers. The commercial value of this residue it is at present difficult to assess, but many engineering experts are of opinion that it is far superior to coal as a steam raiser.

The type of vessel which the conditions of the Petroleum trade has called into existence is that aptly described as the tank steamer, which is simply a vessel divided by transverse bulkheads into watertight compartments or tanks, in which the oil is carried in bulk. The tanks may be divided by a longitudinal bulkhead, which reduces their size to one half. Expansion tanks are provided, and manholes give the men free access to the tanks. In tank steamers the propelling engines are aft, and two bulkheads, with a space between them, are interposed between the aftermost tank. The object of this is to supply a chamber into which the leakage from the tanks may collect, as well as oppose a barrier between the engine space and the oil tanks. Cases are on record where the leaked oil has found its way into the bunkers, with the result that the coals were saturated with oil, and great risk of explosion incurred. Where this intervening space is stored with water the oil accruing from leakage can be easily removed, as by reason of its lesser specific gravity it finds its way to the surface and can be skimmed off, and thus the generation of the dangerous Petroleum vapour is obviated. Tank steamers are fitted with electric light, and the double wire system is being extensively adopted in preference to the more questionable method of employing the single wire with the iron hull of the vessel as the return. The danger of the latter system of installation often militates seriously against successful navigation; as, apart from other risks, the single wire system has been known to produce an error in the ship's compass of from 3° to 7°. Where portable lights are required on a Petroleum ship, wires are switched on to the main cable, and the lamp is usually protected by a strong glass container and a stout wire protector. Such are briefly the outlines of the existent machinery for the over-sea transit of Petroleum in bulk.

It is somewhat remarkable that the destruction of Petroleum vessels by explosion and fire does not seem to be brought about directly by the cargo itself, but rather by the residual vapour which remains in the hold spaces when the oil is partially or wholly discharged.

The dangerous character of this vapour is well known, and its accumulation in a space employed to carry quantities of crude oil not yet deprived of its most volatile constituents must be regarded as an inevitable adjunct to the risks of Petroleum carriage. The maximum danger in the case of tank steamers is reached after the discharge of the oil has taken place, for the oleaginous properties will ensure its adhering to the sides of the tanks when the pumps have removed all they can. One volume of this crude oil is sufficient to render feebly inflammable 2400 volumes of air, and the exposure of such a great evaporating surface supplies the most favourable conditions for the generation of Petroleum vapours. In the bottoms of the tanks there is usually some inches of oil which remains even after the tanks have been filled with sea water and pumped out again. Evaporation must of necessity go on rapidly from such a shallow surface, and the result is that the tank becomes, unless *adequate* means are employed to cleanse and ventilate, a danger space of the most pronounced type.

A brief sketch of three typical disasters occurring on Petroleum vessels will show the glaring deficiencies of the precautionary measures at present adopted in the Petroleum carrying trade. On the 19th December, 1889, the steamship *Fergusons* was discharging at Rouen a cargo of crude oil, shipped at Philadelphia, when a fearful explosion took place, blowing out the mainmast and completely wrecking the after-part of the vessel. In spite of all efforts to extinguish the flames the fire raged until the next day, when the vessel foundered. No trace could be discovered of one of the tank men who was below at the time of the disaster. Her Majesty's Consul at Rouen forwarded to the Home Office a sample of the crude oil carried by the *Fergusons*, and this, on examination by Dr. Dupré, chemical adviser to the Explosives Department of the Home Office, was found to have at the normal temperature a specific gravity of ·7925. This crude oil contains all the most volatile constituents of Petroleum, and this particular sample was capable of rendering inflammable 2400 times its own volume of air. Thus, a gallon would suffice to render inflammable 400 cubic feet of air, and its volatility may be judged of by the fact that the exposure of one foot of oil surface for twenty minutes will make thirteen cubic feet of air explosive. Now, although the employment of electric lighting on oil ships tends in the main to minimize risk, yet imperfect installation supplies a ready method of igniting this Petroleum vapour. At the time of the disaster the dynamo was running, and there is little doubt that the emission of a spark consequent upon the faulty contact of the portable cable and lamp led to the disaster.

Some little while after this the nautical world was startled by the news of a disaster almost without a parallel in the annals of our mercantile marine. A tank steamer, the *Wildflower*, constructed in 1889 for the Petroleum trade and fitted with six cargo tanks, each holding 500 tons weight of oil, was engaged to convey a cargo of crude Petroleum from Philadelphia to Rouen. The voyage was accomplished in safety, and the discharge of the oil was effected satisfactorily until the pumps sucked, leaving in the tanks a depth of oil varying from two to six inches, while in one tank there was some fifteen inches of the crude oil left. Two of the tanks were pumped full of water. The vessel then left Rouen, and on January 8th, 1890, she arrived in the Wear, where she was moored. The tanks were then pumped out, and it was noticed that an oily film spread over the surface of the Wear and was carried seawards by the ebbing tide. Hardly were the pumping operations concluded when an alarm of fire was raised, and the surface of the water in the vicinity of the vessel was covered with smoke and flame. The adjacent shipping was much damaged, the surging flames enveloping them and extending seventy feet into the air, burning the rigging and buckling the stout iron plates with most disastrous effects. One life was lost. Most probably the firing of the oleaginous

film was effected by a red-hot rivet or a piece of burning waste thrown overboard from some ship contiguous to the *Wildflower*. Experiments made with some oil taken from the tanks showed a specific gravity of ·7485, and a power per gallon of rendering inflammable 133 cubic feet of air. When the oil was poured upon water the resulting film was easily ignited by a flame or any brightly red-hot solid. The evaporation of its volatile properties was so rapid that in ten minutes a lighted match failed to ignite the oil, while with twenty minutes' exposure it was necessary to blow a flame upon it to set it on fire, and after half-an-hour it was very difficult to light the oil by any means whatever. The teaching of the *Wildflower* disaster is too important to be ignored. It is dreadful to contemplate what accidents may occur through the presence of Petroleum upon the surface of the waters of crowded harbours. At Batoum the water is usually covered with oil to the distance of three-quarters of a mile from the shore, while practically the same condition of things obtains at Philadelphia.

The teachings of Petroleum disasters are, however, by no means limited to the above two cases. The latest horror occurred on board the steamer *Tancarville*, when in the dry dock at Newport, on the 11th May last. Like the *Wildflower*, the *Tancarville* was built in 1889, and specially constructed for the carriage of Petroleum in bulk. The oil tanks were six compartments, extending from the skin of the ship up to the lower deck, and were sub-divided again by a longitudinal bulkhead. Each tank was fitted with an expansion space, and these again were provided with man-holes. The vessel was equipped with the electric light on the double wire system. The cables were enclosed in a wooden frame and thoroughly insulated from each other. Switches were provided for the purpose of effecting communication between the main and portable cables. The connection was made by a ball and socket lever and covered with a brass cap. There were six portable cables, and the portable lamps were protected by clear glass globes of considerable thickness over the incandescent globes, the glass globes again being protected by four brass bars. The vessel was employed in carrying crude Petroleum from Philadelphia to Havre. She discharged her last cargo there and sailed for Newport on April 18th, which port she reached two days later, and was placed in dry dock on the same date. She went into dock a "dirty ship," *i.e.*, one which was not properly cleansed. A considerable quantity of oil was known to be in the ballast tank, which was a space of about 6000 cubic feet. Some of the oil remaining in the vessel was discharged into the dock and a red-hot rivet falling upon it set it on fire, doing considerable damage to the vessel. This was on the 23rd April. The vessel remained under repairs until May 11th, when an explosion occurred which wrecked the vessel and resulted in the loss of six lives. Several portable forges were being used on board the vessel, as much rivetting of her tanks was necessary. The residual oil in the ballast tank was removed so far as possible by drilling a hole in the bottom of the vessel and allowing the oil to run through into the dock. It was in this ballast tank that the explosion occurred with the violence stated above. The immediate cause of the disaster it is impossible to ascertain, but where portable forges and rivetting are carried on in spaces adjacent to those in which Petroleum vapour must have accumulated, a catastrophe is simply invited. The flames, according to some witnesses, reached as high as the top of the fore-mast, and the wrecking of the vessel is proof of the powerfully explosive character of Petroleum vapour. Assuming that one gallon of the oil would render 200 cubic feet of air feebly, and sixty cubic feet of air strongly, explosive, it will be seen that the presence of very little oil would suffice to fill the empty space of the ballast tank with a highly explosive compound.

What alterations in the pumping and ventilating appliances these disasters will lead to will be watched with the greatest interest. The better cleansing of oil steamers should be insisted upon. Spaces into which oil may leak are perhaps greater sources of danger than the tanks themselves, and adequate provision should be made for their effective cleansing in a thoroughly scientific manner. But the machinery of Petroleum conveyance needs revising and bringing up to date. The powers of harbour authorities are very limited, and they could not make bye-laws that would much diminish the risk unless the owners, and those who have to see to the details of the traffic, become alive to the dangers. They, by the loss of their lives and property, have already the highest incentive to adopt precautions. Refined Petroleum that has a higher flashing point than 73° Fahr. (Abel test), *i.e.*, "mineral oil," as distinguished from "mineral spirit," is outside the pale of the law. The dangers from oils whose vapours ignite at low temperatures are obvious. An eminent firm of oil manufacturers say that they have found some oils *offered for lubricating purposes* which gave off *dangerous* gases at a temperature of between 70° and 80° Fahr.

The Petroleum trade has developed enormously, and is still doing so. It can hardly be said, however, that the conduct of the trade is prosecuted according to the present teachings of science. The development of the trade has been attended with a much greater amount of disaster than even the dangerous nature of Petroleum warrants, and it is to be hoped the object-lessons of the accidents discussed will appeal to all those responsible for a diminution of them. One feature of the trade cannot be too strongly deprecated. The carriage of Petroleum in bulk requires vessels of a vastly different type to the average merchant vessel. Yet the British shipmaster, if he possesses the regulation Board of Trade master's certificate, is considered competent to command a tank steamer, with all its special mechanical apparatus for tank discharge, &c., and electrical equipment. Special conditions require special training, and, at the very least, there should be on every oil steamer a skilled electrician competent to effect repairs and to see that the electrical lighting is carried out on scientific lines.

SEA-URCHINS.

By R. LYDEKKER, B.A.Cantab.

PROBABLY most visitors to the seaside are more or less familiar with the shells of those marine creatures commonly known as Sea-Urchins, or Sea-Eggs, this acquaintance being usually due either to finding them cast up on sandy beaches, or to seeing them offered for sale by the vendors of curiosities and natural history objects. In many instances it is probable that the acquaintance ends here, although in others these objects may have been submitted to a fuller examination; but, in any case, we venture to say it is comparatively few who have studied them with the care and attention that their beauty of form and peculiar structure demands, and still fewer who know anything about their history in past times. Those, however, who care to take up the subject will find it one of more than usual interest, and we accordingly propose in this article to place before the reader some of the leading features and

peculiarities of these creatures, which will form stepping-stones for those inclined to proceed further with their study.

To begin with, Sea-Urchins take their name from the array of movable spines with which the shell is covered during life, and which thus suggest comparison with those of the true Urchin, or Hedgehog. The shell, as it is commonly called, will, indeed, be the portion of the animal to which alone our attention will be directed, since it is only this part that is capable of preservation in a fossil state. We must, however, state at the outset that, as this so-called shell does not by any means correspond in structure with the shell of a mollusc, it is found more convenient to give it a different name, and the term *test* has accordingly been selected. Moreover, since the name Sea-Urchin is a somewhat long one, we may conveniently abbreviate it to Urchin, unless we prefer to use the more technical term Echinoid.

There is great variety in the form of the hard calcareous test of the Urchins, which varies from a shape somewhat resembling a flattened orange to a heart-shape, or even to a thin disc-like plate. The ordinary Urchins shaped somewhat like an orange are, however, those best adapted for gaining a general idea of the structure of the group, and we shall accordingly commence with them.

If, then, we examine such a test, we shall find that it has an aperture at each of the two poles; while it is divided into a series of meridional areas, each composed of a number of separate oblong calcareous plates, fitting accurately with one another at their edges, where they are united by a thin membrane. The upper surface of such a test is shown in Fig. 1, from which it will be seen that the upper or apical pole, as it may be conveniently called, consists of five somewhat heart-shaped plates surrounding a small circular orifice which is closed with membrane in the living state. This central orifice is the *vent*, while the five plates forming a star surrounding it, which generally fall out in the dry state, constitute the *apical disc*. At the opposite or lower pole, we shall find a much larger aperture, which forms the creature's mouth; and we may observe that just inside this aperture of the test in the complete animal, there will be found a very complicated calcareous masticating apparatus known as *Aristotle's lantern*. Putting aside for the present the apical disc, we may devote somewhat fuller attention to the main body of the test, technically termed the *corona*. As we have said, this consists of a series of meridional areas composed of numerous small plates; and we shall find that these areas form ten alternating series, each of which consists of two meridional rows of the aforesaid plates. The line of division between the two rows in each area is well marked, although the divisions between any two areas are much less distinct. It will further be seen that, while in one series of areas (*i a*) the plates are much wider than in the other series (*a*), they are also somewhat deeper. Now, if we were to look from the inside of the test towards the light, we should find that the outer half of each plate in the narrower areas has several minute perforations; and it is through these minute perforations that, during life, the animal protrudes the curious tube-like feet, by the sucker-like action of which an Urchin is enabled to climb up the glass wall of an aquarium. As these narrower areas are connected with the function of progression, they are appropriately termed the *ambulacral areas*, and the larger intervening spaces are accordingly called the *intermediate areas*. It is almost superfluous to add that the whole test of an Urchin thus consists of five ambulacral and five intermediate areas, which between them comprise twenty separate rows of plates, each running continuously from one polar aperture to the other. During life each plate is separated from its neighbour by a thin membrane, and the test increases in size both by additions to the edge of each plate and also by the interpolation of fresh equatorial zones of plates between the upper edge of the corona and the apical disc. The spines of the Urchins are movably attached to the knobs with which the test is covered, and vary much in form and size, although the limits of this article do not admit of further reference to them.

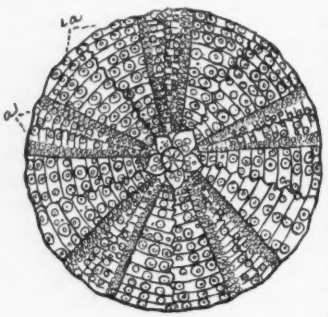


Fig. 1.—Upper Surface of the Test of the Common Sea-Urchin. *a*. Ambulacral areas; *i a*. intermediate areas.

Reverting to Fig. 1, we may also see that the ambulacral areas of the Common Urchin form a five-rayed star, on the test of which, in the position of the figure, three rays are turned away from the spectator and two towards him. Now this radiate arrangement at once forciby reminds us of a Star-Fish, and any person who has ever handled those creatures when alive will be aware that from their under surface they can protrude tube-like sucking feet, precisely similar to those we have referred to as existing in the Urchins. Both these points of resemblance are, indeed, indicative of an intimate relationship between Urchins and Star-Fish. And, as a matter of fact, the ambulacral areas of the one represent the five rays of the other; the intermediate areas of the Urchins being an addition to the structure of the Star-Fish. At first sight it looks, indeed, as if these animals were really symmetrically radiate, but we shall show later on that this is not the case, and that they are, in truth, bilaterally symmetrical like the higher animals, although this bilateral symmetry has been more or less thoroughly masked by the radiate arrangement of the parts.

Urchins and Star-Fishes are, however, not the only members of the group of Echinoderms; since this also comprises the beautiful Stone-Lilies or Encrinites, the joints of the stems of which form the well-known "St. Cuthbert's Beads," of the Whitby Lias, while the so-called Entrochal Marble, so often employed for chimney-pieces and other decorative architecture, is almost entirely composed of these stems. There are, moreover, certain entirely extinct types, such as the Cystoids and Blastoids, of which more anon.

Before proceeding to trace the modifications which the test of the Urchins undergoes in different members of the group, it may be observed that in all Urchins, whether recent or fossil, the number of meridional areas is invariably ten; while in every existing kind of Urchin, no matter what be its size or shape, the number of rows of plates composing such areas never departs from twenty. As soon, however, as we reach the strata lying below the chalk and gault, known as the lower greensand, which constitute the lower part of the Cretaceous system, we find an Urchin which departs somewhat in the last-named respect from the existing type. A side view of the test of this species is given in Fig. 2, from which it will be seen that while at the apical pole the number of meridional rows of plates is the normal twenty, as we approach the equator the number of meridional rows in each intermediate area is increased to four, which continue to the

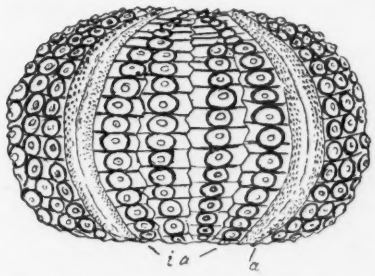


FIG. 2.—Side view of the test of a Cretaceous Sea-Urchin (*Tetracidaris*). Letters as in Fig. 1.

basal pole. Going still further back to the Trias, we find another genus of Urchins (*Tiarechinus*) with an increase in the number of rows of plates in the intermediate areas above the lower pole. Moreover, some of the Urchins of the still older Jurassic rocks differ from the ordinary type, in that the plates overlap one another instead of joining by their edges.

These departures from the normal form in some of the Secondary Urchins suggest that, if we were to go back to the Palæozoic epoch, we should find still more marked differences from living types. Such, indeed, is actually the case, and we find that all the Palæozoic Urchins differ from existing ones in the number of meridional rows of plates, while very frequently these plates overlap one another. In the specimen represented in Fig. 3 it will be seen that while the ambulacral areas are normal, the intermediate areas have now no less than five meridional rows of plates; while in yet another form (*Melonites*) the ambulacral as well as the intermediate rows are increased in number, the former varying from seven to eight, and the latter from eight to fourteen. With one exception, however, all the Palæozoic Urchins agree with the Common Urchin in having the vent situated at the apical, and the mouth at the basal pole, this mouth always having the "Aristotle's lantern."

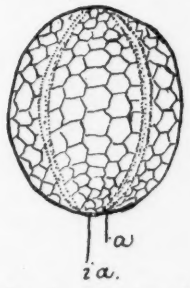


FIG. 3.—Side view of the test of a Palæozoic Sea-Urchin (*Palæoechinus*). Letters as in Fig. 1.

Now if we proceed still further back till we reach the lower part of the Palæozoic epoch, such as the Cambrian and Lower Silurian, we shall find a totally extinct group of Echinoderms known as Cystoids. The hard parts of these creatures consist of a nearly globular test, usually supported on a short stalk, and composed of a number of polygonal plates, having no definite meridional arrangement, but traversed by five, or fewer, irregular ambulacral grooves radiating from the mouth. And it will be obvious that, in their large number of meridional rows of plates, the Palæozoic Urchins present a much closer resemblance to these extinct Cystoids than is offered by their existing representatives. Indeed, if we believe in the derivation of one form of animal from another, it seems pretty evident that starting from the Cystoids—the oldest known Echinoderms—we can pass readily into the Palæozoic Urchins, from which we are conducted by the above-mentioned intermediate Secondary forms to species of the type of the Common Urchin of the present day. What particular advantage the modern Urchins have gained by the reduction of their meridional rows to twenty is, however, not very easy to determine; although this reduction has probably conduced to greater compactness and strength in the structure of their test, which may alone have been a sufficient improvement on the older types.

The transition from the Palæozoic to the modern forms does not, however, by any means exhaust the modifications which the Urchins have undergone with the march of time. Reverting once more to the Common Urchin (Fig. 1), it should be mentioned that this type, in which the test is radiately symmetrical and the vent and mouth are polar, constitutes the group of the so-called Regular Urchins. Although this type is still well represented, yet a large number of the Urchins of the Secondary, Tertiary, and recent periods have departed very considerably from this simple form, to assume a more or less decided heart-shape, with one or both apertures of the test becoming eccentric, and with a frequent tendency for the perforated portions of the ambulacral areas to become restricted to the central part of the upper surface, where they form a flower-like pattern (Fig. 4). Such types constitute the group of Irregular Urchins, which, on the doctrine of evolution, may be safely regarded as derived from the Regular group. Moreover, not satisfied with the assumption of these new shapes, the Irregular Urchins appear to have considered the "Aristotle's lantern," which had served their ancestors as a masticating organ for countless ages, only a useless encumbrance, and, accordingly, the more advanced "radicals" among them have totally discarded this piece of apparatus, and, indeed, appear to get on equally well without it.

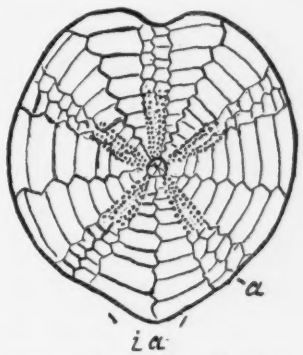


Fig. 4. — Upper surface of the test of a Cretaceous Heart Urchin (*Micraster*). Letters as in Fig. 1.

The forms connecting the more aberrant members of the Irregular with the Regular group of Urchins are both numerous and varied. Among them we may refer to the common little Helmet Urchin (*Echinoconus*) of our chalk. The test of this species is about an inch in height, and forms a tall cone, which is not quite radiately symmetrical. The mouth, indeed, retains its usual position at the basal pole, while the perforated areas extend from pole to pole. In place, however, of the vent being situated in the centre of the apical disc, it has been transferred to the margin of the lower surface, in the middle of one of the intermediate areas. It is thus placed opposite to an ambulacral area corresponding to the one directed upwards in Fig. 1; and we thus, for the first time, find a regular bilateral symmetry fully established. In the particular species to which we have referred (as in all the under-mentioned forms), the "Aristotle's lantern" has been lost, although it is retained in other members of the same group. One specimen of a Helmet Urchin has been discovered showing the rare abnormality of having but four ambulacral areas.

A further step is shown by the so-called Sugar Loaf Urchin (*Ananchytes*) of the English chalk, the tall silicified tests of which are so commonly found in the gravel derived from the denudation of the chalk. In this species, which is considerably larger and more ovoid than the Helmet Urchin, the elevated form of the test is still retained, but the contour of its under surface has become more decidedly heart-shaped. Moreover, the vent has become shifted completely on to the lower surface; while the mouth, although remaining (as is invariably the case) on the under surface, has travelled away from its original central position so as to be placed in the ambulacral area

corresponding to the one directed upwards in Fig. 1. Here, therefore, we have the bilateral symmetry still more distinctly marked. Another advance shown in this Urchin, is the circumstance that the perforated portions of the ambulacral areas do not extend on to the lower surface of the test, but stop short at the edge. Some members of the same family are still more peculiar in that the apical disc is greatly elongated from front to back, in consequence of which the five ambulacral areas do not all meet one another at the summit of the test; those corresponding to the three turned away from the spectator in Fig. 1 meeting near the middle of the test, while the remaining two are brought together in the opposite part of the test corresponding to the lower portion of Fig. 1.

A third common chalk species, the Heart-Urchin, or Fairy Heart of the quarrymen (*Micraster*), affords a good example of what may be regarded as the extreme modification of structure developed in the group. The upper surface of one of these Urchins is represented in Fig. 4, from which it will be seen that the contour is regularly heart-shaped, and the whole test much depressed. The perforated portions of the ambulacral areas are now restricted merely to the central region of the upper surface, one of these areas (directed upwards in the figure) forming a shallower groove, and being otherwise markedly different from all the others. In such an Urchin the bilateral symmetry is very strongly marked indeed, and, since the upper border of the figure represents the anterior, and the lower the posterior extremity of the animal, we may compare the three anterior ambulacral areas to the head and arms of a quadruped whose hind legs will be represented by the two posterior ambulacra. In regard to the position of the two orifices of the test in this species, the vent is situated on the flattened posterior surface, near its junction with the upper surface, while the mouth occupies a position nearly midway between the centre and the anterior border of the lower surface, at the commencement of the groove formed by the anterior ambulacral area. The mouth is peculiar in that it does not open directly on the surface, in the usual manner, but has a projecting lip by means of which its aperture assumes a forward direction. The common Purple Heart-Urchin (*Spatangus*) of our present seas is a larger representation of this group, presenting the same general type of structure.

We thus see how gradual is the passage from a species of the type of the Common Urchin to that of the Heart-Urchin, widely different as are these two from one another. We might, indeed, proceed further with our investigations, and show how certain of the Irregular Urchins have become so flattened as to assume the form of thin plates, which in some instances are deeply notched at their periphery. And we might also investigate the variation of form and size displayed by the spines of the different groups. Enough has, however, been written for our present object, which has been to show the amount of interest that attaches to the investigation of the lines of modification on which development has proceeded among the Sea-Urchins. This has shown how a regular progressive advance in one particular direction has taken place from the earlier to the later members of the group; and we thus have another excellent instance testifying in favour of the doctrine of evolution. This brief sketch may possibly give additional pleasure to a sea-side sojourn, by inducing some of our readers to direct their attention, first of all, to the recent Sea-Urchins, after which they will scarcely fail to extend their investigations to the fossil species so abundantly distributed through our rocks; and, we will venture to add, that if they do so their interest cannot fail to be aroused.

THE FACE OF THE SKY FOR DECEMBER.

By Herbert Sadler, F.R.A.S.

THE markings on the solar surface show no signs of diminution. The following are conveniently observable minima of some Algol-type variables (*cf.* "Face of the Sky" for November). U Cephei.—December 1st, 10h. 9m. P.M.; December 6th, 9h. 49m. P.M.; December 11th, 9h. 28m. P.M.; December 16th, 9h. 8m. P.M.; December 21st, 8h. 48m. P.M.; December 26th, 8h. 28m. P.M.; December 31st, 8h. 7m. P.M. Algol.—December 15th, 11h. 43m. P.M.; December 18th, 8h. 31m. P.M.; December 21st, 5h. 20m. P.M. A minimum of the variable star Mira (Omicron) Ceti will occur on the 29th of December. The magnitude at minimum varies from 8 to $9\frac{1}{2}$ magnitude, and the star is of a fiery red colour at that stage.

Mercury is an evening star, and would be well situated for observation during the first three weeks of the month but for its great southern declination. He sets on the 1st at 4h. 42m. P.M., or 49m. after the Sun, with an apparent diameter of $5\frac{1}{2}''$, and a southern declination of 25° 49′, $\frac{8}{10}$ of the disc being illuminated. On the 13th he sets at 5h. 8m. P.M., or 1h. 19m. after the Sun, with an apparent diameter of 7·0″, and a southern declination of 24° 36′, $\frac{53}{100}$ of the disc being illuminated. About this time he is at his brightest. On the 18th he sets at 5h. 10m. P.M., or 1h. 20m. after the Sun, with an apparent diameter of 8·0″, and a southern declination of 23° 20′, $\frac{38}{100}$ of the disc being illuminated. After this he rapidly approaches the Sun, coming into inferior conjunction with him on the 28th. He is at his greatest eastern elongation ($20\frac{1}{2}$°) on the 11th, and in conjunction with λ Sagittarii on the morning of the 7th, but the phenomenon will not be visible in Europe. While visible he describes a direct path in Sagittarius. Venus is also an evening star, but is almost as indifferently placed for the observer as Mercury is. She sets on the 1st at 4h. 56m. P.M., or 1h. 3m. after the Sun, with a southern declination of 24° 23′, and an apparent diameter of $10\frac{1}{2}''$, $\frac{95}{100}$ of her disc being illuminated, while her brightness is less than one quarter of what it was at the beginning of the year. On the 31st she sets at 6h. 4m. P.M., or 2h. 6m. after the Sun, with a southern declination of 20° 35′, and an apparent diameter of $11\frac{1}{4}''$, $\frac{9}{10}$ of the disc being illuminated. During the month she passes from Sagittarius into Capricornus, but without approaching any conspicuous star.

Both Mars and Uranus are, for the purposes of the amateur, invisible; and Saturn does not rise on the last day of the month till 11h. 9m. P.M. We therefore defer our ephemeris of him till next year. Jupiter is still favourably placed for observation as an evening star, but should be observed as soon as possible after sunset. He sets on the 1st at 11h. 33m. P.M. with a southern declination of 9° 12′, and an apparent equatorial diameter of $40\frac{1}{4}''$, the phasis on the preceding limb amounting to $40\frac{1}{4}''$. On the 31st he sets at 9h. 46m. P.M. with a southern declination of 7° 37′, and an apparent equatorial diameter of $36\frac{3}{4}''$. The following phenomena of the satellites occur while Jupiter is more than 8° above, and the Sun 8° below, the horizon. On the 1st an occultation disappearance of the first satellite at 6h. 12m. P.M., and an eclipse reappearance of the same satellite at 9h. 49m. 21s. P.M. On the 2nd a transit egress of the first satellite at 5h. 39m. P.M., and of its shadow at 7h. 0m. P.M. On the 4th an occultation disappearance of the second satellite at 7h. 7m. P.M., and an eclipse disappearance of the fourth satellite at 9h. 25m. 11s. On the 5th a transit egress of the third satellite at

6h. 21m. P.M., and a transit ingress of its shadow at 8h. 26m. P.M. On the 6th a transit ingress of the shadow of the second satellite at 5h. 2m. P.M.; a transit egress of the satellite itself at 5h. 10m. P.M.; and a transit egress of its shadow at 7h. 51m. P.M. On the 8th an occultation disappearance of the first satellite at 8h. 9m. P.M. On the 9th a transit ingress of the first satellite at 5h. 17m. P.M.; of its shadow at 6h. 38m. P.M.; a transit egress of the satellite at 7h. 36m. P.M., and of its shadow at 8h. 55m. P.M. This transit should be carefully watched, as the satellite may possibly appear to be double. On the 10th an eclipse reappearance of the first satellite at 6h. 13m. 53s. P.M. On the 11th an occultation disappearance of the second satellite at 9h. 46m. P.M. On the 12th a transit ingress of the third satellite at 6h. 59m. P.M., and of the fourth satellite at 7h. 20m. P.M. This will be a very interesting phenomenon. On the 13th a transit ingress of the second satellite at 4h. 57m. P.M.; of its shadow at 7h. 39m. P.M.; and a transit egress of the satellite itself 11m. later. On the 16th an eclipse reappearance of the third satellite at 5h. 36m. 44s. P.M.; a transit ingress of the first satellite at 7h. 14m. P.M.; of its shadow at 8h. 34m. P.M.; and a transit egress of the satellite itself at 9h. 33m. P.M. On the 17th an eclipse reappearance of the first satellite at 8h. 9m. 26s. P.M. On the 18th a transit egress of the shadow of the first satellite at 5h. 20m. P.M. On the 20th a transit ingress of the second satellite at 7h. 38m. P.M. On the 21st an eclipse reappearance of the fourth satellite at 6h. 41m. 48s. P.M. On the 22nd an eclipse reappearance of the second satellite at 7h. 12m. 51s. On the 23rd an eclipse disappearance of the third satellite at 6h. 37m. 2s. P.M., and a transit ingress of the first satellite at 9h. 13m. P.M. On the 24th an occultation disappearance of the first satellite at 6h. 34m. P.M. On the 25th a transit ingress of the shadow of the first satellite at 4h. 59m. P.M.; a transit egress of the satellite itself at 6h. 1m. P.M.; and of its shadow at 7h. 16m. P.M. On the 29th a transit egress of the fourth satellite at 6h. 42m. P.M. On the 30th an occultation disappearance of the third satellite at 5h. 31m. P.M. On the 31st an egress of the shadow of the second satellite at 5h. 0m. P.M., and an occultation disappearance of the first satellite at 8h. 33m. P.M. During the month Jupiter describes a direct path in Aquarius, but without approaching any naked eye star very closely.

Neptune is excellently situated for observation, rising as he does on the 1st at 3h. 38m. P.M., with a northern declination of 19° 58′, and an apparent diameter of 2·7″. On the 31st he rises at 1h. 50m. P.M., with a northern declination of 19° 51′. During the month he describes a short retrograde path to the north of ε Tauri. A map of the stars down to 10½ magnitude near his path will be found in the *English Mechanic* for October 16th, 1891.

December is a fairly favourable month for shooting stars, the chief shower being that of the Geminids on December 9th–12th, the radiant point being in R.A. 7h. 0m., and north declination 32°, rising about 4h. 10m. P.M., and setting at 1h. 40m. A.M.

The Moon enters her first quarter at 5h. 13m. P.M. on the 8th; is full at 0h. 53m. A.M. on the 15th; enters her last quarter at 5h. 38½m. on the 23rd; and is new at 3h. 20m. A.M. on the 31st. She is in perigee at 6·1h. P.M. on the 11th (distance from the earth, 228,540 miles); and is in apogee at 6·0h. P.M. on the 23rd (distance from the earth, 241,300 miles). The greatest eastern librations are at 1h. 7m. P.M. on the 3rd, and at 1h. 30m. A.M. on the 30th; and the greatest western at 4h. 18m. P.M. on the 17th.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

ALL COMMUNICATIONS for this column should be addressed to the "CHESS EDITOR, *Knowledge Office*," and posted before the 10th of each month.

SOLUTION OF PROBLEM No. 5 (*by D. R.*) 1. Kt to K4. If 1. . . . K×Kt; 2. Kt to B7, etc. Or if 1. . . . K to K3; 2. Kt (from K8) to Q6, etc.

CORRECT SOLUTIONS from:—Alpha, Betula, H. S. Brandreth, Giu. Pianissimo, C. T. Blanshard, G. F., W. E. B., W. T. Hurley, J. G. Ellis, R. T. M., F. R., R. W. Compton, C. S., White Knight, M. B. (Jesmond), T., A. Rutherford, R. W. Houghton, and J. Taylor.—(19 correct, 1 incorrect.)

J. E. Smith.—See above for correct solution.

C. T. B.—You sent two replies, both correct (Nov. 3rd and 7th).

W. T. Hurley.—Duals do not count, except of course in the key-move. See rules in June number.

T.—Well-known problems would be inadmissible in a solution tourney. The game you refer to has been ably annotated elsewhere.

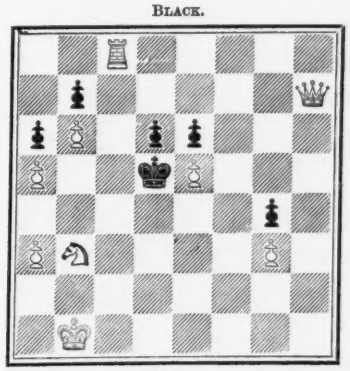
C. S.—The problem seems all right now. Shall be glad to insert early in the next tourney.

Black Combe.—Your letter was delayed. Will reply next month.

PROBLEM (No. 6).

By C. D. L.

BLACK.



WHITE.

White to play, and mate in three moves.

LEADING SOLVERS' SCORES.

Alpha	30	A. Rutherford	30
W. E. B.	30	T.	30
W. T. Hurley	30	J. Taylor	30
Giu. Pianissimo	30	Betula	26
F. R.	30	K.	22
R. W. Houghton	30	T. A. Earl	22
G. F.	30	J. G. Ellis	22
C. S.	30	White Knight	22
M. B. (Jesmond)	30	H. S. Brandreth	19
C. T. Blanshard	30	R. W. Compton	16
R. T. M.	30		

CHESS INTELLIGENCE.

The score in the recent Divan Tourney was as follows:—Bird, 6½; Tinsley, 5½; Müller, 5; Loman and Jasnagrodsky, 4½; Mortimer, Fenton, and Rolland, 4; Van Vliet and Gossip, 3½. The scoring was singularly even, the result of a large number of drawn games.

The Rev. A. B. Skipworth and Mr. J. H. Blake, who tied for first prize at the Oxford meeting of the Counties' Chess Association, played off their tie at the British Chess Club last month. After a hard struggle Mr. Blake proved the winner by two games to one, one game being drawn. Mr. Skipworth failed to make the most of his opportunities in more than one game.

The Championship Tournament of the City of London Club, and a Handicap at the British Chess Club, are now in progress. Mr. Loman is a notable absentee in the former contest. In the "British" Handicap Mr. Hoffer is in Class Ia by himself, giving the rather heavy odds of pawn and move to Class I.

Messrs. Steinitz and Tchigorin are announced to play a return match at Havana, at the end of this month, the match to go to the winner of the first ten games, draws not counting. The length of the match is all in Mr. Steinitz's favour.

The following game was played at the Oxford meeting of the Counties' Chess Association last August.

[Centre Gambit.]

WHITE (Dr. Hunt, North London).	BLACK (J. H. Blake, Southampton).
1. P to K4	1. P to K4
2. P to Q4	2. P×P
3. Q×P	3. Kt to QB3
4. Q to K3	4. Kt to B3 (*a*)
5. B to K2 (*b*)	5. P to Q3 (*c*)
6. B to Q2	6. B to K2 (*d*)
7. QKt to B3	7. Castles
8. Castles	8. R to Ksq (*e*)
9. Q to Kt3	9. B to Bsq
10. B to KKt5 (*f*)	10. B to K2
11. P to B4 (*g*)	11. Kt to Q2
12. Kt to B3	12. B×B
13. Kt×B	13. Kt to Bsq (*h*)
14. P to K5	14. B to K3
15. KKt to K4	15. K to Rsq
16. P×P	16. P to B4
17. P×P	17. Q×P
18. Kt to B5	18. Kt to Kt5
19. Kt×B	19. Kt×Kt
20. B to Kt5 (*i*)	20. Kt×KBP
21. R to Q7 (*j*)	21. Kt to K7ch
22. B×Kt	22. Q×R
23. B to B4 (*k*)	23. Q to Q5
24. B to Kt3	24. R to K6
25. Q to B7 (*l*)	25. R to Qsq
26. R to Qsq	26. R to K8
27. Q×Rch	27. Q×Q, and wins

NOTES.

(*a*) Usually played now; the old defence by 4. . . . B to Kt5ch; 5. P to B3, B to R4; 6. Q to Kt3, Q to B3; 7. P to B4 not being very satisfactory for Black. Instead, however, of 6. . . . Q to B3, he may play 6. . . . Kt to B3, for White dare not play 7. Q×KtP, R to KKtsq; 8. Q to R6, Q to K2! followed by . . . R to Kt3.

(*b*) This, or B to Q2, is probably the best move. After 5. P to K5, Kt to KKt5; (or 5. . . . Kt to Q4; 6. Q to K4, Kt to Kt3; 7. Kt to KB3 (or P to QR4 ?), Q to K2, even game); 6. Q to K2! (not 6. Q to K4, P to Q4; 7. P×P *en passant*, B to K3; 8. P×P, Q to Q8ch!); 6. . . . P to Q3; 7. P to KR3, KKt×KP; 8. P to KB4, Kt to Q5; 9. Q to K4, Q to R5ch; 10. K to Qsq. Black saves the piece by Kt to K3! with a winning game.

(*c*) If 5. . . . B to K2; 6. P to K5 with the better position. An interesting game might result from 5. . . . B to Kt5ch; 6. P to B3, B to R4; 7. P to K5, B to Kt3; 8. Q to Kt5 (or 8. Q to B4, Kt to Q4; 9. Q to Kt3); 8. . . . B×Pch; 9. K to Bsq, Kt to K5; 10. Q×P, R to Bsq; 11. B to R6, and should win perhaps, for if 11. . . . B to B4; 12. P to QKt4!

(*d*) Or 6. . . . B to K3; 7. QKt to B3, P to Q4; 8. P×P, Kt×P, with a good game.

(*e*) White has taken for his model a recent correspondence game between Glasgow (White) and North London (Black). Black at this point continued 8. . . . P to Q4; 9. P×P, Kt×P; 10. Q to B3. The game was ultimately won by White. The text move is better. 8. . . Kt to KKt5 is met by 9. Q to B4 (best), P to KKt4?; 10, Q to Kt3.

(*f*) Defending the Pawn and threatening Kt to Q5.

(*g*) A weak move on principle. The Pawn cannot advance and may desire in vain to retreat. Kt to R3 seems safe enough, for if . . . B×Kt; 12. P×B with the open Kt's file. 11. B to Kt5 would obviously lose a piece by 11. . . . Kt to KR4.

(*h*) P to KR3 was now necessary, though White might play Kt×P, and B to R5ch.

(*i*) Here P to QR3 should have been played, followed by Kt to Q5.

(*j*) An oversight. P to QR3 or R to Q2 was still available.

(*k*) If 23. B to Kt5, Kt×RPch; or if 23. P to QR3, Kt to R7ch.

(*l*) If 24. R to Qsq, Q to K4. At his next move 25. Kt to Ktsq would be answered by R×B! The ending was very well played by Black.

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For all places outside the Postal Union, 5 shillings in addition to the postage.

Communications for the Editor and Books for Review should be addressed, Editor, "KNOWLEDGE" Office, 326, High Holborn, W.C.

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